

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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| | |
|--|---------------|
| PRESIDENTIAL ADDRESS BEFORE THE AMERICAN SURGICAL ASSOCIATION | 113 |
| THOMAS W. HUNTINGTON | SAN FRANCISCO |
| THE VALUE OF THE TRANSFUSION OF BLOOD IN THE TREATMENT OF THE WOUNDED IN WAR | 118 |
| ALEXANDER PRIMROSE | ENG |
| THE RÔLE OF THE EVACUATION HOSPITAL IN THE CARE OF THE WOUNDED | 127 |
| DANIEL FISKE JONES, M.D. | BOSTON |
| THE RELATION OF ORTHOPÆDIC TO GENERAL SURGERY | 133 |
| GUYM G. DAVIS, M.D. | PHILADELPHIA |
| CLINICAL OBSERVATIONS CONCERNING MALIGNANT TUMORS OF THE JAWS | 136 |
| ALBERT J. OCHENER, M.D. | CHICAGO |
| RECURRENT DISLOCATION OF THE LOWER JAW | 141 |
| JOHN BAPT BLAKE, M.D. | BOSTON |
| TWO CASES OF ENLARGED THYROID PRODUCING SUFFOCATION BY DISPLACEMENT BENEATH THE STERNUM | 146 |
| H. BEECKMAN DELATOUR, M.D. | BROOKLYN |
| AN APPLICATION TO EMPYEMA OF THE PRINCIPLES UNDERLYING THE USE OF ANTISEPTICS | 148 |
| EDWARD K. DUNHAM, MAJOR, M.R.C. | NEW YORK |
| HEMORRHAGE FROM AN ANEURISM OF THE INTERNAL CAROTID ARTERY, FOLLOWING SEPTIC SORE THROAT | 152 |
| JOSEPH RANSCHOFF, M.D., F.A.C.S., F.R.C.S. (Eng.) | CINCINNATI |
| POST-OPERATIVE THORACIC DRAINAGE | 156 |
| WILLY MEYER, M.D. | NEW YORK |
| THE TREATMENT OF DISEASES OF THE COSTAL CARTILAGES | 168 |
| ALEXIS V. MOSCHCOWITZ, M.D. | NEW YORK |
| THE SURGICAL TREATMENT OF THE CIRRHOSIS OF THE LIVER AND THEIR COMPLICATIONS | 183 |
| W. J. MAYO, M.D. | ROCHESTER |
| CHOLECYSTITIS | 188 |
| F. G. N. STARR, M.B., AND ROSCOE R. GRAHAM, M.B. | TORONTO |

CONTINUED ON PAGE 1

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PRESIDENTIAL ADDRESS BEFORE THE AMERICAN SURGICAL ASSOCIATION

By THOMAS W. HUNTINGTON, M.D.

OF SAN FRANCISCO, CAL.

DELIVERED JUNE 6, 1918

FELLOWS: I am deeply grateful for the distinguished honor, of which I was made the recipient at the meeting in Boston. The announcement came to me as a surprise beyond expression; as it is safe to say, it has come in turn to each of the men eminent in American surgery, whose illustrious names adorn the roster of past presidents of this association.

We will all agree that the advent of each of us to membership in this body was a red letter day in our careers, and an achievement worthy of any man.

For my own part, I wish to assure you that my life has been made very happy by the close relationship, by the elbow touch and the helpful hand you have generously accorded to me. But what to me is more precious, is the splendid friendships which have come to me. I sincerely hope they are merited, and will endure to the end.

In accepting the trust you have seen fit to confide in me, I again thank you from my heart, and to this I add in all sincerity, that I choose to interpret your action as an expression of affectionate regard.

Together we note to-day the significant absence of many familiar faces. We shall miss greatly the cordial greeting of men who continuously, and for many years, have lent much of dignity and interest to these meetings. One and all they are conspicuous as leaders of thought, and disciples of science, tireless workers in the search for truth.

But regret, if that we have, finds small place in contrast with our pride in the assurance that from us, as from a family, have gone forth a battalion of strong men, devoted and brave, to do their part unselfishly in the world's great tragedy, and to bear a message from American surgeons, to bleeding France and to our stricken allies.

It is an inspiration to know that fully one-half our Fellows are or have been "over there."

With broader vision let us unite in splendid tribute to American surgeons, to our colleagues throughout this great country, living and dead, who have freely given their service and their lives in the cause of human liberty.

Let those of us who for good reason remain behind strive to keep the

THOMAS W. HUNTINGTON

home line unbroken. Let us be mindful that it is ours to serve where service lies, and above all, to lend comfort and courage, by limitless faith in the ultimate realization of a world redeemed.

While our voices swell the anthem to a universal and a righteous peace, let us join with Tennyson, when he sings,

"All is well! though faith and form
Be buried in the night of fear.
Well roars the storm for those who hear
Above the storm a deeper voice,
Proclaiming all is well for social justice, human right."

INDUSTRIAL MEDICINE AND HEALTH INSURANCE

The theme I have selected for discussion to-day, by an abrupt departure from precedent, carries us into the realm of social economics; an interest which is engaging the best thought of all who are enrolled in the cause of human betterment. Despite an apparent innovation, I offer no apology for having ventured to discuss one of a large group of problems, which have their genesis in social democracy; avowedly the most dominant, moral, intellectual and political factor in modern civilization.

This group includes several measures that are already operative through legislative enactment, providing for workman's compensation and industrial accident insurance. Several other very radical reforms are contemplated, some of which will undoubtedly, in the near future, be incorporated in our state or federal statutes. Among these are old age pensions, death benefits, pensions for widows and orphans, unemployment insurance and, finally, the most comprehensive and revolutionary of all, *health insurance*, whereby the medical care of the industrial worker and his dependents becomes a governmental function.

You are doubtless aware that agitation for the legalizing of socialized medicine is widespread, and that in response to popular clamor it will, sooner or later, inaugurate a new phase of human experience in America, as it has already done in several European countries.

It may be futile, possibly unwise, to challenge the propriety of this impending reversal of form; and it certainly is not my purpose to question the altruism of its proponents. Nevertheless, I am frankly apprehensive lest the pendulum of popular desire may swing too far, and lest unwittingly we find ourselves committed to the cause of making the world safe, not only for Democracy, but for Socialism.

For more than a century we have had repeated examples of the misadventures of Socialism. Its catchwords, *liberty*, *equality* and *fraternity*, were the basis of the sinister creed of the communes of 1789, of 1879 and 1917 in Russia; a creed whose ritual, though oftentimes amended and revised, still embodies too many of its insufferable tenets.

For this reason if for no other, I believe that this Association should subject every feature of this "parting of the ways" to very careful analysis,

PRESIDENTIAL ADDRESS

and be prepared to meet it with firmness, tact and intelligence. It is axiomatic that in the world's experience really beneficial reforms have been evolutionary and not revolutionary. Furthermore, America should not follow too implicitly the teachings of Germany, or even of England and France in the solution of her social problems. Our traditions and our ideals are not altogether in harmony with those of older civilizations. Jealous of our individual rights, we are resentful of centralized compulsion and control. In a word, any scheme which proposes to radically affect our economic status should be translated into terms of American customs, American habits and American institutions. At the close of a half century of industrial unrest and resentment and turmoil, the American wage earner has begun to reap the benefits of workman's compensation and accident insurance enactments.

The history of this transition has been indelibly written; the old regime is behind us and we are living under a new social order. Very readily we recall the years when little heed was paid to social welfare—a maximum of profit for a minimum of cost was the shibboleth of business. How men of toil lived, how they fed and reared their families, or what became of the breadwinner when advancing age set its seal upon their careers found small place in the day's accounting. A woeful disregard for the principles of *Safety First* was manifest, and in the onrush of enterprise, little value was accorded to loss of life or limb. Safety appliances, by hesitant step and grudgingly, were finally adopted, not as a voluntary concession or an economic need, but as the result of aggressive legislation. It is true that provision for the care of sick and injured was established at an early day, but this, especially in the railroad and mining industries of the far west, was founded upon the assessment plan, whereby the financial burden was carried by the beneficiaries.

As a rule, there was a central organization, oftentimes a hospital, supplemented when necessary by local medical services. The administration of funds was uniformly conducted by individual employers or corporation officials, and the amount and quality of service was limited, first, to the available resources and, second, to the efficiency of local professional talent. Patterning after the pioneer organizations of the frontier, benefit associations of various types sprung rapidly into existence and in almost every community came to be regarded as an essential factor in industrial welfare. The assessment plan was uniformly adhered to, though in some instances funds were augmented by contributions from employers. In isolated instances, and under very wise direction, such foundations are and will continue to be operated successfully. But the inherent defects of such a system are obvious, and the public has begun to realize that the prevailing plan is inadequate and unsatisfactory.

From the beginning, the compensation of industrial surgeons has been pitifully small. The value of an official appointment by corporations because of prestige has been greatly overestimated. With some notable exceptions, too little scientific interest was developed, and low standards of efficiency

THOMAS W. HUNTINGTON

were exacted by those in authority. Undoubtedly, the scheme was fostered as an economic vantage rather than a moral responsibility.

The question of liability for loss of time, permanent injury or death, was left to the conscienceless awards of the claims adjuster, or to the slower and more disheartening processes of the courts.

Looking back upon the time when the ingenious but unwholesome doctrine, based upon "*the fellow servant rule*," "*the assumption of risk*" and "*contributory negligence*," was an established principle in the settlement of disputes between the employer and the employed, we can easily account for the recent awakening of public conscience, and the development of a keener sense of social responsibility. Likewise, we discover in evolution the final cause of a reform, which is universally accepted as in the common interest of human justice and possibly as an escape from a grave national peril.

Quickly following the advent of liability and accident legislation, there has been inaugurated an aggressive campaign for provision for *health insurance*, which, according to Rubino, is based primarily upon the doctrine "that organized society should furnish that protection to one part of the population, which some other part may need less, or if needing, is able to purchase through private insurance."

You are aware that social insurance in all its aspects bears the legend "made in Germany," for there it had its beginning. In fact, this is one of the few accredited governmental functions which can be regarded as of German initiative.

While her example was followed by other nations, perhaps blindly, it is by no means certain that, as an innovation, it has proven an unmixed blessing. With a clear understanding of German melting pot methods in moulding public sentiment, and with utter detestation of that sinister thing—*German Kultur*—we should hesitate long before subscribing to a dictum or a doctrine emanating from such a source.

In theory the distribution of collective losses and elimination of individual risk is fundamental in all types of insurance, and despite the fact that its application to this phase of economic need is of doubtful propriety, it is nevertheless true that health insurance has found an army of enthusiastic proponents in the ranks of welfare workers and wage earners.

That time-honored aphorism, "Laws are made for the greatest good of the greatest number," is coming to be too narrowly interpreted, where direct class benefits are in question; and in my opinion it is clearly the part of wise conservatism to insist that the greatest measure of human justice to the majority be recognized as a more wholesome and far safer rule of organized society.

Unfortunately, and too often, in seeking a remedy for existing ills, immediate gain, with an undercurrent of self-interest, is the fanfare which leads to ultimate, irretrievable loss.

Health insurance commissions have been created in several states and they are busily engaged in discussing details and formulating proposed

PRESIDENTIAL ADDRESS

statutes. At the November election in California a constitutional amendment, an enabling act will be submitted, which, if carried, will pave the way for specific enactments. Very soon a widespread, aggressive campaign will be inaugurated in an effort to place this enforced remedy upon the statute books.

The attendant cost of this measure in the aggregate will confessedly be colossal. About thirty millions of people will participate as beneficiaries of the fund, for whom the following provisions are to be made. Surgical, surgical and dental care, including hospital and nursing service, laboratory facilities, radiography and appliances of various types. Conservatively the scheme will entail an expenditure of nearly a billion dollars annually. Primarily this will be apportioned to the employee, to the employer and to the state in a ratio to be determined. Secondarily, it will be reflected to the tax-payer and, ultimately, as with all governmental cost, to the consumer.

Administration of the various funds will rest with the state and thereby become an important factor in our political organization. That the expense of administration will be formidable is a foregone conclusion, and it seems inevitable that in and around the organization there will be built a gigantic machine, an engine of political conspiracy.

The consequences of this prospective cure for social ills, as reflected upon industrial enterprise, professional welfare, individual initiative and national character are of tremendous import.

This paper, academic in tone, is limited to mere suggestion of issues that sooner or later will be joined. More careful analysis and consideration of these issues must be deferred until occasion arises. You are, however, warned that scientific medicine is confronted by a movement which runs contrary to all traditions, a movement which will undoubtedly tend to lower potential energy and inhibit future progress. Clothed with governmental authority, officialdom will barter the services of the profession, either individually or in groups, arbitrarily and by schedule, and compensation will be forthcoming in accordance with legal rating.

I am free to say that the time has arrived when the financial status of medical men should be amply safeguarded. Call this commercialism if you will, but let me remind you that for ages the medical profession has stood alone among all classes of society in shunning the stigmata which we have voluntarily attached to the word commercialism. The world at large places a high estimate upon financial achievement, and financial failure is universally deplored. Success is measured by the yardstick of the banker, and altruism is a by-product of enterprise. The dollar sign is not and should not be our hall mark, but in the interests of professional dignity and of justice it is clearly our right, our duty, to conserve and protect our economic welfare.

THE VALUE OF THE TRANSFUSION OF BLOOD IN THE TREATMENT OF THE WOUNDED IN WAR*

By ALEXANDER PRIMROSE, C. B., M.B.C.M., (EDIN.),
COLONEL, C.A.M.C.

Two years ago, in conjunction with my colleague Major (now Lt. Colonel) E. S. Ryerson, I read a paper at Salonika on this subject before the Salonika Medical Society. The society was composed of members of the Royal Army Medical Corps and of the Canadian Army Medical Corps then stationed in Macedonia: we also had a few French medical officers as visitors. We had had a few cases in which transfusion was employed, in No. 4 Canadian General Hospital at Salonika. The first of these was on Xmas Day, 1915, when a man suffering from a compound comminuted fracture of the upper third of the femur was admitted in a desperate condition suffering from shock and hemorrhage. We believed his life was saved by transfusing 815 c.c. of blood from a fellow patient in our tent hospital. A second case where hemorrhage threatened to prove fatal was transfused with 1100 c.c. of blood. Both of these patients made good recoveries and were reported in our paper, which was afterwards published in the *British Medical Journal* of September 16, 1916. Subsequently some eight cases were transfused in our hospital at Salonika. Unfortunately, the hospital records are not available for the purposes of this paper and I cannot give the details, but it is worthy of note to observe that in one of these hæmolysis occurred, and the patient, after transfusion of 200 c.c., showed embarrassment of respiration, puffiness of the face and eyelids, with marked congestion of the conjunctivæ, so that the transfusion was of necessity stopped and the patient subsequently succumbed. This case illustrates the necessity of preliminary tests of the blood of the donor and of the recipient to prevent if possible such an occurrence by determining whether or not hæmolysis is likely to occur.

Early in the war surgeons were tardy in recognizing the value of transfusion of blood as a life-saving measure in cases of hemorrhage in the wounded. In April, 1917, Colonel Cuthbert Wallace gave us a most valuable contribution to the literature of the surgery of the war in his analytical study of 1200 cases of gunshot wounds of the abdomen. While recognizing that "hemorrhage is the greatest enemy of the surgeon," he makes the following comment:

"The treatment of hemorrhage after operation is not satisfactory, and repeated saline infusion is powerless to prevent a fatal issue. Transfusion of blood and of citrated blood has been tried, and papers have been published by Major Edward Archibald and Captain L. Bruce Robertson of the Canadian A. M. C. These cases are as yet too few to enable an estimate to be made of its efficiency in the class of case under discussion."

* Read before the American Surgical Association, June 6, 1918.

TRANSFUSION OF BLOOD IN WAR

In Robertson's series of 68 cases, which I am about to quote, there were five of wounds of the abdomen. Of these four died, one of gas bacillus infection, one of hæmolysis, two who were in a desperate condition after operation showed only temporary improvement after transfusion and finally succumbed to their injuries. The success attained, however, in the fifth case illustrates the fact that at all events the element of hemorrhage as a cause of fatality may be eliminated, provided the bleeding points can be secured. The case was one in which abdominal injuries were complicated by a fractured femur. The spleen and the bladder were torn. Splenectomy was performed and the bladder sutured. Transfusion of 1000 c.c. of blood was then accomplished. The systolic blood-pressure rose from 80 to 185 mm. of Hg. The patient made a complete recovery and was heard from as convalescent some weeks after his arrival in England.

In civil practice among the surgeons of this continent, prior to the war, the immense value of the transfusion of whole blood in cases of hemorrhage was established in hundreds of instances where it had been employed. Many patients in a desperate condition from severe hemorrhage have been first transfused and then carried through serious major operations successfully and have subsequently had a normal convalescence leading to complete recovery. One may quote a single case from the writer's experience of a woman, forty-two years of age, suffering from a fibroid tumor of the uterus. She was admitted to hospital blanched and pulseless, with a red cell count of 1,800,000 and hæmoglobin 15 per cent. She was restless, with sighing respirations. By transfusion from her son we gave her 820 c.c. of blood and performed an immediate hysterectomy. She made an uninterrupted recovery. Numerous other examples might be cited, cases of severe gastric hemorrhage, hemorrhage from various forms of traumatism, etc., in which patients were admitted to hospital in a critical condition from hemorrhage. Such patients when transfused became good operative risks and were in many instances carried safely through serious operative procedures.

Then again in pre-war times the value of transfusion in cases of secondary hemorrhage has been demonstrated many times. My first case of this kind was eight years ago, when a lad twenty years of age was admitted to my service in the Toronto General Hospital. He had cut the calf of his leg with an axe ten days previously, severing the posterior tibial artery, and was in a critical condition from secondary hemorrhage. Blood examination showed 2,850,000 red cells with 40 per cent. hæmoglobin. His brother served as donor and he was transfused. Crile's cannulæ were used for the purpose. The wound, which was in a sloughy condition when he was admitted, healed rapidly after transfusion, and the patient recovered. Transfusion in such cases of secondary hemorrhage increases the coagulability of the blood, and improves the local resistance of the tissues to infection.

Facts proving the value of transfusion of blood in hemorrhage and more especially in hemorrhage accompanied by shock have been firmly established. Since it was first done by the Canadians in the early months of the war it

ALEXANDER PRIMROSE

has become gradually more and more employed on the battle-field until to-day it is very extensively used on the western front, not only by the Canadians but also by the British Imperial service. More recently the Americans, who had proved its value long before war broke out, have promptly utilized the transfusion of blood as a life-saving measure among the wounded men.

One of our Canadian officers, Captain H. E. Clutterbuck, has furnished me with records of certain cases transfused by him when serving in an Imperial Casualty Clearing Station. I may quote two of these as typical examples.

On January 16, 1918, a private was admitted suffering from multiple shell wounds: the right forearm was shattered, the left humerus fractured, the right femur broken, the femoral artery being ruptured just above the popliteal space. There was also a through-and-through wound of the left foot fracturing the fifth metatarsal bone. He was admitted twelve hours after receiving his wounds. He was very cold, very pale and very quiet. The pulse was imperceptible, the temperature was 98 and respirations 28. He was transfused ten hours after admission with 500 c.c. of blood by the use of Kimpton's tube. Immediately afterwards the wounds were all cleansed by free excision of all damaged tissues, amputation was performed through the right thigh, the operation taking fifty-five minutes. His pulse after operation was 116 and his systolic blood-pressure 80; next day it rose to 120. He steadily improved; by the fifth day the pulse had fallen to 90, and the wounds were all doing well. He was evacuated to the base on the sixth day after operation.

A second case was that of a private admitted in January, 1918. A bomb had exploded at his feet and blown off his right foot just above the ankle and also fractured both bones of the same leg at the upper third. On admission he was cold, pale and pulseless, he was conscious but very quiet. Warmth and restoratives were employed and 3 pints of normal saline were given subcutaneously. After some six hours the body warmth was somewhat restored and the pulse became discernible and was counted with difficulty at 130. He was then transfused by the direct method for twenty minutes with whole blood from vein to vein, using Fullerton's tubes for the purpose. The leg was then amputated under chloroform. He was evacuated to the base six days afterwards in good condition. In this case the blood-pressure was recorded at 54 mm. of Hg at the beginning of transfusion. It rose to 164 when transfusion was stopped and dropped to 108 during the operation. One hour after the operation it had again risen to 150 mm. of Hg.

Major L. Bruce Robertson, who was on duty in a Canadian Casualty Clearing Station in France, published in the *British Medical Journal* of November, 1917, the details of 36 cases in which transfusion was done in hemorrhage. More recently he has prepared a paper, which will soon be

TRANSFUSION OF BLOOD IN WAR

published, detailing his complete series of 68 cases.¹ He has permitted me to refer to his results and the analysis he has made of the cases in his forthcoming publication. Other cases of transfusion were done in the same Clearing Station, bringing the total number in that particular hospital unit up to something over 100. Major Robertson's cases were classified as follows:

| | |
|---|----------|
| 1. Primary Hemorrhage: | |
| (a) Life saving (evacuated to Base Hospital in good condition).... | 36 |
| (b) Immediately beneficial but died from | |
| 1. Shock | 8 |
| 2. Gas gangrene | 5 |
| 3. Capillary bronchitis | 1 |
| 4. Pulmonary embolism | 1 |
| | 15 |
| (c) No benefit | 4 |
| (d) Harmful (hæmolysis) | 2 |
| 2. Secondary Hemorrhage | 9 |
| Of these 6 recovered and 3 died. Of the 3 that died 1 death was due to hæmolysis following a second transfusion. One died of gas gangrene three days after transfusion. One died of streptococcus septicæmia 1 month after transfusion. | |
| 3. Severe carbon monoxide poisoning | 2 |
| Grand total | 68 |

The two cases of carbon monoxide poisoning were men who were buried in a dugout in which certain combustible material caught fire. Venesection with the removal of 1000 c.c. of blood in two stages gave moderate relief, but their condition remained grave. On this account 1000 c.c. of blood was transfused. This did not appear to produce any immediate effect, but the following day improvement was evident and the patients recovered.

The Casualty Clearing Station at which these cases were transfused was situated some eight miles from the firing line. The wounded were sent back over very uneven ground and, in bad weather, the mud made transportation extremely difficult. In consequence, from six to twelve hours (occasionally as much as twenty-four hours) would elapse before the wounded man reached hospital. An attempt was made to establish an advanced operating station but this had to be abandoned because of the enemy shell fire. The delay, the pain and the fatigue consequent upon transportation, over rough country, increased the shock and collapse. Many of these patients were therefore in extremely bad shape when they arrived in hospital. Rapid pulse and low blood-pressure were characteristic features presented. The immediate effect of transfusion was to raise the blood-pressure and to produce a slow full pulse. This is shown in the records which were kept of the

¹ Since writing this article Major Robertson has published his paper; it is entitled "A Contribution on Blood Transfusion in War Surgery." L. Bruce Robertson, *Lancet*, June 1, 1918, p. 759.

ALEXANDER PRIMROSE

individual cases and indicates a quick response to the therapeutic measure employed, the immediate beneficial effect being maintained in the vast majority of instances.

Many of these cases were desperate from the outset and it is noteworthy that of 68 cases reported life was saved in 44 instances, i.e., 64.7 per cent. In other words, the mortality in these cases was 35.3 per cent. This would appear to be a remarkably good showing. It is worthy of note also that an immediate beneficial result was obtained in 15 of the cases which subsequently succumbed to conditions other than hemorrhage. One is justified in concluding that the transfusion of whole blood practically eliminates the danger of death from hemorrhage *per se*.

Major Edward Archibald has reported 8 cases of transfusion in hemorrhage. Four of these were done in three patients for secondary hemorrhage at the base, and four patients were transfused at the front. Of the latter two died of gas gangrene and two from profound shock. Of those transfused at the base two died of repeated hemorrhages. One who was *in extremis* at the time made a remarkable recovery. All of these cases were described by Major Archibald as being "In a very desperate condition, indeed practically moribund" at the time of transfusion.

In May, 1917, Fullerton, Dreyer and Bazett of the Royal Army Medical Service reported a series of fifteen cases transfused at the British front and in addition three cases from other hospital units of the R.A.M.C. Of these 18 cases there were 8 recoveries. In one instance where the left kidney was wounded by a high explosive shell, secondary hemorrhage occurred thirty days afterwards. The kidney was removed and immediate transfusion was performed. The improvement in the patient's condition was described as dramatic and recovery ensued.

The experience which has been already attained in the treatment of the wounded at the front has been ample to prove the immense value of transfusion in cases of hemorrhage, both primary and secondary. We agree with the conclusions of Archibald and Maclean that transfusion of blood is valueless in shock. Where, however, shock is accompanied by hemorrhage then transfusion has proved of immense value and we may conclude that its employment may turn the scale so that life in many instances has been saved where shock plus hemorrhage exists. In fact, we are warranted in assuming that whenever the wounded man has lost large quantities of blood then the replacement of that blood is the ideal therapeutic measure. Such patients when transfused have the element of danger which exists from loss of blood eliminated. They are in a vastly better position to combat shock, sepsis, the ordeal of some necessary and perhaps extensive operation, or other condition which may threaten life. In other words, by transfusion we believe we can largely eliminate the danger which exists from hemorrhage and by replacing the lost blood may materially aid him to combat other conditions which might without transfusion prove fatal. We can by transfusion place the man in the position of one similarly wounded but who has lost no large amount of blood.

TRANSFUSION OF BLOOD IN WAR

We do not propose in this paper to discuss methods to any extent. The citrate method has many advantages and the use of Kimpton's tubes has been found serviceable. The writer has mainly employed a modification of the syringe and cannula method introduced by Lindeman and in one case found the two-way stopcock apparatus of Unger answer admirably. I understand the Americans on the Western front have ingeniously succeeded in keeping blood drawn from the donor in cold storage for forty-eight hours or more in anticipation of an emergency.

The author has had no experience in immunized blood for use in septic cases. This has been termed "vaccination transfusion." The donors are immunized by doses of vaccines prepared from the particular virus before the transfusion is undertaken. Heyd and R. S. Hooker have recently reported successful cases. The former in endocarditis with a blood culture of streptococcus viridans, the latter in four cases of staphylococcus septicaemia. The possible application of such methods to war surgery is obvious.

The amount of blood transfused has varied. The writer has frequently transfused 1000 c.c. and in one case 1140 c.c. from one donor. Robertson mentions five cases of the injection of 1200 c.c. In none of these instances has the donor suffered other than very temporary inconvenience. The desirable amount must be determined in the individual case, but in hemorrhage one aims at from 600 to 700 c.c. as a minimum while in the majority of instances of severe hemorrhage it would appear that a larger amount, say 1000 c.c., is more effective.

There are mainly two dangers to be avoided in the transfusion of blood—the transfusion of some infective disease and the danger of hæmolysis. The donor should be carefully examined for the purpose of excluding syphilis or other communicable diseases. The blood of both donor and recipient should be tested in order to determine their iso-agglutinin characteristics. As Ottenberg has pointed out the most severe and possibly fatal reactions occur when the serum of the recipient agglutinates the corpuscles of the donor, but other conditions of incompatibility while unlikely to cause serious disturbance will lessen materially the therapeutic value of transfused blood.

Meleney, Stearns, Fortune and Ferry, in a study of 280 transfusions, find that the more transfusions a patient is given the more likely he is to have a reaction, especially if the same donor is used a large number of times. These reactions are considered in all probability to be due either to an intravascular hæmolysis or to the formation of a toxic product from the partial splitting of a foreign protein. At the front it has been difficult or impossible to secure laboratory facilities for the proper blood tests and under such circumstances it has been held that one is justified in proceeding without such tests. The cases are desperate and the demand for prompt action is imperative: the danger from hæmolysis, while very real, is not so great as to make it unjustifiable to proceed in urgent cases without investigating the characteristics of the blood. Recently the question of the prevention

of hæmolysis by suitable tests has received a great deal of attention. It has been shown that in human blood two iso-agglutinins and two iso-hæmolysins may be demonstrated. Absence of both iso-agglutinins or the presence of one or both of them in an individual sample of blood permits the classification of human blood in four main groups. Moss utilized such a classification and prepared two standard human sera, each serum containing one of the iso-agglutinins. These sera were used for testing the blood of the donor as well as that of the recipient. When the blood of the donor and that of the recipient showed a similar reaction one would be satisfied that a suitable donor had been secured. These standard sera may be secured and kept for a considerable period. The test may be done by simple methods as suggested and carried out by Moss or by a method, based on the same principle, described by Lee. The employment of the two standard sera has become the method of choice at the front and is now very generally in use.

Captain Karsner has recently published a paper on transfusion with tested bloods. He tested the blood of 1000 soldiers in the base hospital to which he was attached: the percentage of individuals in each of the four blood groups (using the classification of Moss) differed little from the results arrived at by Moss and by Sanford, except that Group No. 1, in which the sera contain no agglutinins, was only found in 3.1 per cent. of the cases as against 10 per cent. by Sanford and 8 per cent. by Moss. On the other hand, Group 4, in which the corpuscles do not possess suitable receptors and therefore cannot be agglutinated by any serum, was found in 46.2 per cent. of the cases as against 47 by Moss and 43 by Sanford. This Group 4 constitutes what has been called the universal donor. Karsner suggests that prospective donors might be tested and in cases of emergency where tests cannot be made Group 4 only be used, so that the most dangerous form of hæmolysis, namely, that in which the corpuscles of the donor are hæmolized by the serum of the recipient, may be eliminated. That hæmolysis is a real danger is shown by the fact that Robertson reported three cases out of his series of 68. One of the ten cases at Salonika and one of Archibald's series of 8 developed hæmolysis. Archibald's case recovered. The other four died. It would not be fair to assume that death was directly due to hæmolysis in any of these instances, as the patients were already in a desperate condition from other causes, but in all instances where hæmolysis occurs the effect must necessarily be harmful and the transfusion only tends to hasten the fatal issue.

The writer was a member of the Inter-allied Surgical Congress which met in November, 1917, at the French Army Medical School, Val-de-Grâce, in Paris. It was then determined to investigate the value of the transfusion of blood at the following meeting, the subject to be introduced by Professor Tuffier. Accordingly, at the last meeting of the Congress at Paris, in March, 1918, this was done. After full discussion it was concluded that the results obtained by the transfusion of blood justify its being looked upon as the method of choice in the treatment of serious hemorrhage, both primary

TRANSFUSION OF BLOOD IN WAR

and secondary. It was agreed that the method of transfusion employed should make it possible to measure the quantity of blood transfused. Regarding the danger of hæmolysis it was concluded that at advanced posts it is justifiable to resort to transfusion even if it be impossible to test the agglutination, as the risk of serious results is relatively small, but it should be tested in all other units.

The surgery of the present war has been remarkable for the progressive developments which have occurred in the treatment of the wounded soldier.

Many of our pet theories regarding the treatment of wounds have been ruthlessly upset and effective and revolutionary measures for the saving of life and limb have been evolved, and are to-day successfully carried out in our hospital corps from the front line to the base. For the first time in war the transfusion of whole blood has been carried out successfully and no treatment has been more spectacular or effective as a life-saving measure in cases of hemorrhage.

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THE RÔLE OF THE EVACUATION HOSPITAL IN THE CARE OF THE WOUNDED*

BY DANIEL FISKE JONES, M.D.
OF BOSTON, MASS.

THE value of the time element in the treatment of wounds in this war is of such importance it has made imperative the treatment of the wounded within ambulance drive of the front. This would hardly seem to need amplification, yet in talking with many medical officers who have not yet been to France and come in contact with the gas bacillus and streptococcus, its importance and difficulty of accomplishment do not seem to be realized. This in part is due to the emphasis laid on the importance of the various antiseptics by those who have returned after visits to the hospitals in France. They have told us of the wonderful results obtained at La Panne and Compiègne, and have made little of the fact that patients in these hospitals are received directly from the front, usually within twelve hours of the time of being wounded.

We were at General Hospital No. 22, B.E.F., when some of these enthusiastic reports came out, and often wished that these observers could visit us and see what the wounded looked like in the base hospitals, about three days after being wounded and with little or no early treatment.

We all appreciate the advantage of early operation in infected abdominal cases, but the importance of time is not so well appreciated in relation to wounds of other parts.

Tarnowski¹ says, "While the research casualty clearing station (British) is not ready to render a final report on the various solutions employed, the results so far tend to prove that the *sine qua non* of success lies, not in the antiseptic used, but in the (early) radical excision of the devitalized tissues."

If one had any doubts as to the value of early and thorough treatment of wounds, those doubts would have been dispelled if he had visited the area with which I was associated. There, ward after ward of a two thousand bed hospital, and hospital after hospital of the same size, were filled with practically nothing but wounds infected with the gas bacillus or the streptococcus, and the average time of arrival at the hospital was three days after being wounded.

In the same area was one experimental ward filled with patients who had been brought directly from the front by ambulance and had been operated upon within twelve hours, by an experienced surgeon under Sir George Makin. These cases were, in addition, treated by the Carrel-Dakin method. About 80 per cent. of the wounds were closed successfully within ten days,

* Read before the American Surgical Association, June 6, 1918.

¹ Journal of the A. M. A., March 16, 1918.

DANIEL FISKE JONES

while the patients in all the other hospitals were sent to England in from three days to six weeks with many more wounds than they came with, all discharging pus freely and with no suggestion of bony union in the compound fractures.

If we admit that time is an important factor, it is evident that some scheme must be worked out for the thorough treatment of these cases at the front, for while the base hospitals of which I speak were only forty or fifty miles from the front, the time by ambulance train was from twenty-four to thirty hours.

In looking over the different units, it was evident that the casualty clearing station, which corresponds to our evacuation hospital, was the one best suited for development of this work.

Bowlby and Wallace² say: "The development of the casualty clearing stations has been the most important factor in the creation of a new school of surgery at the front, and it is not too much to say that they have saved many thousands of lives which would have been lost but for the surgical opportunities which they have provided. Before the war, the casualty clearing stations appeared only on paper and as untried units, for they did not exist at the time of the South African war. They were originally called clearing hospitals, and their proposed function was merely to clear the field ambulances and pass the patients on to the base hospitals. Their equipment, therefore, was only very slight and their staff of eight officers, including the command officer and the quartermaster, was less than the staff of a field ambulance. They carried two hundred stretchers and were supposed to be able to deal with the same number of patients."

The original British force went to France with six of these units, but it was soon discovered that they were to be a very important link. Beds and bedding were first added, then trained nurses, surgical equipment, and a special surgeon. These hospitals have been added to in various ways, up to the present time, and in 1916 more than fifty were at work, each with a capacity of from four hundred to twelve hundred wounded.

In 1916 these units were fairly well equipped to care for the wounded in ordinary times, but even then lacked much necessary equipment for good work, especially a sufficient supply of X-ray apparatus. Since 1916 much has been added, but by far the most important change of all has been in the way of making these units elastic. They are now a nucleus about which a great mobile force of medical units gather during a battle, to care for the great number of wounded. It is well known that hospitals of all kinds, evacuation, field, and base hospitals, have periods when comparatively little is going on. With the aid of the motor car, operating teams, nurses, and orderlies can be collected from the inactive units, in a comparatively few hours, and brought to the sector in which the battle is about to begin or has begun.

Perhaps more important still than these borrowed teams are the mobile units, or *auto-chir* of the French. These are absolutely complete and inde-

² Abstracts of War Surgery.

THE RÔLE OF THE EVACUATION HOSPITAL

pendent hospital units, including X-ray apparatus and from five to ten operating teams, on automobile trucks, which can easily be moved from one sector to another, as is needed. With operating teams from the base hospitals, and inactive evacuation hospitals, operating teams and hospital equipment from the field hospitals, and the complete hospital and staff of the mobile units, the evacuation hospital becomes a wonderfully elastic and efficient organization. It is a great satisfaction to know that the United States Medical Service has at least one of these mobile units, most wonderfully equipped, and several more under construction.

The sending of teams from the base hospitals to the evacuation hospitals, while of great benefit to the evacuation hospital, is undoubtedly one of great importance in training surgeons, for they are in this way given an opportunity to see the results of work done at the evacuation hospitals. If in 1916 the men from the casualty clearing stations had been sent to the base hospitals even for a week they would have changed their methods without doubt. The furnishing of a sufficient number of wards, as to whether they shall be tents or wooden shacks, the supplying of nurses *et cetera*, are details difficult to arrange, which I cannot go into here. The location of the evacuation hospital is of great importance, for the patients must be brought to them easily, and evacuation must take place easily and rapidly. In these days of the motor ambulance, it would seem that the placing of the evacuation hospitals would depend somewhat more upon other factors, such as railroad accommodations, avoidance of artillery fire, the avoidance of having to move with every thrust of the enemy, and the peace of mind of the patients, rather than upon the close proximity to the front line for the purpose of easy transportation. A distance of fifteen, twenty, or even twenty-five miles from the front would make little difference to the wounded, after they are once in the ambulance, and the great delay is usually between the trenches and evacuation hospital. A large number of ambulances would be required, but they are more easily obtained than new evacuation hospitals if they are lost because too close to the lines. Again, ambulances can be drawn from the quiet sectors to help out in the busy ones. To offset the disadvantage of the larger hospitals being placed far back of the lines, small evacuation hospitals can be established close to the lines for the treatment of very urgent cases, as the British do at present.

It will be seen that the evacuation hospital must be a combination of field and base hospitals. In location and in the early treatment of the wounded it may be considered a field hospital; in size, permanency, equipment and the work it does, it may be considered a base hospital. The combination makes this hospital a difficult one to equip and maintain. To equip it with all that is necessary to care for the wounded during ordinary times would be comparatively easy, but to equip it and carry on the work required of it during a battle, is the difficult problem.

In spite of all efforts to meet the demand for immediate and thorough treatment of the wounded, it must be impossible in the great battles to care

for all the wounded within the prescribed time of twelve hours, but much can be done to help out in these times by sending cases direct to the base hospitals, by ambulance train. Many chest cases, many gutter wounds, all wounds of the soft parts, without fracture, many head injuries which do not open the skull, may be sent direct without doing much harm to the patients.

Before leaving the evacuation hospital in all its glory, let us take a look at its work from a base hospital. During the Somme drive from September to December, 1916, we had the good fortune to be at General Hospital No. 22, of the B.E.F., a very active base hospital, through which nine thousand patients passed in three months. It was located between forty and fifty miles from the front, but was between twenty-four and thirty hours by ambulance train from the casualty clearing station. It was kept filled with wounded from the various casualty clearing stations, and only rarely a case direct from the front line hospitals. The wounded arrived on an average of three days after being wounded, and included all varieties of wounds, except the urgent abdominal cases. All cases were infected with gas bacilli or streptococci. All, or at least a very large proportion of all, the cases had been operated upon at one of the front line hospitals, or a casualty clearing station. In every convoy from one to five immediate amputations were necessary, while all other wounds, except an occasional rifle or shrapnel ball wound, would have to be opened up wide, and fragments of shell and clothing removed. Some cases were already moribund and no operation would be of avail. Knee-joints would come to the hospital with fragments of shell and clothing in them; legs and arms would come to us gangrenous, because a main artery had been tied, and the original wound had become infected; head injuries, with or without fragments of shell in the brain, arrived at the base hospital with meningitis or discharging foul pus. These were the conditions not only in our hospital but in all others in the region, and this was the condition when Bowlby and Wallace state that there were fifty casualty clearing stations with the British forces, well equipped, and with a capacity of about forty thousand beds. If this was the condition to be found in other regions, of what value were the casualty clearing stations, and how can these results be improved?

It must be understood that the medical service was working under great stress at this time. The enemy was very active, the British were pushing forward, and the country in which the British were fighting was almost entirely without shelter, and was wet and boggy, all of which caused great delay in picking up the wounded on the field, and in getting them to the casualty clearing station.

Bowlby and Wallace^{*} show that out of a series of two hundred abdominal cases only one hundred and sixty-four arrived at the casualty clearing station within twelve hours; that is, sixty-six, or 33 per cent., arrived so late that they had little chance of recovery because of the elapsed time alone.

^{*} Abstracts of Surgery.

THE RÔLE OF THE EVACUATION HOSPITAL

Many men were left wounded on the field twenty-four hours, others, three or four days before being found. This will account for the septic condition of many, the inability to care for the wounded promptly at the casualty clearing station, because of the great numbers which came in and because the operating teams from the base hospitals and the mobile units were not yet being used, will account for others, and the lack of equipment, particularly X-ray apparatus, will account for a few others. With all these reasons, we still have a large number of septic cases to account for. There are, we believe, two reasons for these remaining cases.

First, the majority of surgeons at the casualty clearing station had never been at a base hospital, to see the result of the work done at the casualty clearing stations. The second, and, we believe, by far the most important reason of all, was that the casualty clearing station was considered a front line hospital, and had not yet been dignified by a complete staff of experienced surgeons, except for an experienced man to do abdominal work. It is generally admitted that men of experience and ability are needed for abdominal work, but for the other wounds few appreciate that they are necessary.

We have heard of the splendid results obtained at La Panne and Compiègne, by the Carrel-Dakin treatment, but few appreciate that this treatment in these hospitals consists not alone in the use of Dakin's solution, but in the thorough mechanical cleaning of the wound within twelve hours, by that veteran of war surgery Depage, and by that master of delicate technic Carrel, and men trained by them. It would no doubt be admitted that young and inexperienced men in their places would find great difficulty in getting comparable results. It is a very strong statement to make, but we believe that the value of the casualty clearing stations in 1916 was almost nullified; in fact, much harm was done by them, except in abdominal cases, because of inexperienced surgeons. Almost every case which came to the base hospital had been operated upon, some necessarily, at a division or corps hospital or a casualty clearing station. This operation, which was incomplete in nearly all cases, delayed the arrival at the base hospital where there was an experienced staff, by one or more days, making the average time of arrival there about three days after being wounded. The wounds were then so infected that another extensive operation, with many incisions and removal of shell fragments and pieces of clothing, was necessary. Without the intervention of the casualty clearing station, the wounded would have arrived at the base hospital in from twenty-four to forty-eight hours, a considerable saving of important time. As an excuse for this statement, I may say that it was made to the representative of the Director General and the Director General of the B. E. F. in France, in October, 1916.

It will be seen, therefore, that, to make the evacuation hospital most effective, the patient should arrive within twelve hours, and this factor it is impossible to control because of the enemy and the character of the country,

but more important still the staff must be made up of surgeons of ability and experience.

There is an effort to keep the experienced men in our base hospitals down to 40 per cent. of the staff, which is important, but of still greater importance is the keeping of the experienced men who are to work at the evacuation hospitals up to 100 per cent. From experience at a base hospital, I am convinced that the evacuation hospitals and mobile units should first be equipped with staffs of surgeons of well-known ability and experience, after which the base hospitals should receive their 40 per cent. of experienced surgeons, if it is possible to get them.

That the number of men needed in the evacuation hospitals will be large, cannot be doubted. Major Dehelly told me that he could properly operate upon but twenty cases in twenty-four hours. Tarnowsky^{*} states that a team in a French *auto-chir* had operated upon sixty-seven cases in twenty-four hours, but it is probable that the average team could care for nearer twenty than sixty-seven cases, if the work is thoroughly done, and it is useless to waste time doing any operation unless it is thoroughly done.

It must be difficult, I am sure, for any who have not seen the wounds of this war at a base hospital in France, to appreciate in any way the terrible infections seen there. The deaths, the disabilities, the suffering and enormous loss of time caused by sepsis, which in turn is caused largely by delay and inefficient operations, are impossible to compute. If you will follow in your minds the course of a patient with an infected compound thigh fracture with splintering of several inches of femur, and then the course of a similar case properly cleaned and the wound immediately closed, or closed in ten days, then multiply the difference by many thousands, you will get a slight idea of the value of the evacuation hospitals, when properly equipped and with permanent staffs of surgeons of known ability and experience, aided by mobile units and operating teams from various base and field hospitals and inactive evacuation hospitals.

NOTE.—It is to be noted that the conditions described in this paper existed in the British Expeditionary Force up to January, 1917, only. Many changes were made after that date.

While the evacuation hospital was of great importance during the periods of trench warfare, it has been of little value since the present drive began in March, 1918. With the present conditions on the Western Front an entirely new problem in the care of the wounded must be solved.

^{*} Review of War Surgery and Medicine, March, 1918.

THE RELATION OF ORTHOPÆDIC TO GENERAL SURGERY

By GWILYM G. DAVIS, M.D.

OF PHILADELPHIA

THE task that confronts our Government of caring medically for the soldiers of our Army is so great that it is our duty to see that unnecessary difficulties are not created by either avoidable lack of knowledge or positive misunderstandings, otherwise harmony is lost, antagonisms are created and efficiency destroyed. There seem to be some grounds for believing that a certain amount of lack of knowledge and even distrust exists as regards the work of the military orthopædic surgeon, not only among the line officers, but also the military surgical staff. This will, I am sure, disappear when the proper sphere of the orthopædic surgeon is once known. He is a newcomer in the military field, but he is no interloper. He did not enter unbidden. A need was felt for his services and he was asked to help. The reason his aid was requested was because a large amount of work was necessary to be done and he was the only one qualified to do it. He appears at this time because work of an entirely new type is required which heretofore has been neglected. A higher standard is required of the soldier and better care of his necessities is demanded. For these the services of an orthopædic surgeon are essential.

When the line officer knows how much the orthopædic surgeon can improve the condition and increase the efficiency of his men he will welcome him and utilize his services, and when the general surgeon realizes that it is neither the mission nor the desire of the orthopædist to appropriate his cases or interfere with his prerogatives then will he not only be tolerated but perhaps consulted with and treated as a colleague and co-worker in a different field.

The necessity for the orthopædic surgeon has arisen from the fact that cripples of all kinds must be restored, as far as possible, to serviceable condition. I am afraid that neither our people nor our Government as yet fully realize that the time has passed when the disabled soldier can be cast on the community with his wounds healed but still unprepared to meet the necessities arising from his changed condition. Most of these cases can and should be so improved and trained as to fit them to be to a greater or less extent self-supporting and independent of public and private charity. To do this requires a different and more extended treatment than has heretofore been attempted and specially educated surgeons are necessary to carry it out. Our land has numerous hospitals and many able surgeons to treat emergency cases. The limit of stay in many is set at three months, but for cases demanding treatment for from three months to a year or more, we have made little or no provision. I know from considerable experience how the general surgeon feels when he finds four or five of his surgical

beds occupied by tuberculous bone or joint cases, osteo-arthritics, and other human wrecks. Many of these cases present no interest from an operative standpoint and they cannot be treated effectively by any other than the most exacting, time-consuming, and troublesome means. The general surgeon is not to be blamed for his attitude toward this class of cases, because they are not in their proper place, they belong somewhere else.

It is not desired to make any plea for the military orthopædist: If he is not needed and not wanted, put him out, but then the work he does must be done by the general surgeon and it behooves him to qualify himself for the task, and this he has neither the time, the facilities nor the inclination to do. The general military surgeon is amply occupied with attention to matters of sanitation and the general health of his troops in camp and with acute surgery and wound treatment in active service or in the hospitals. He is called to do all the visceral surgery he is able to do and more of the surgery of the extremities than he desires to do.

A man recently presented himself who was injured three years ago. He was wounded by shrapnel and still had a paralysis of the ulnar nerve, an ununited fracture of the ulna and a stiffened elbow. The general surgeons had saved his arm, but surely no one would begrudge an orthopædic surgeon trying to recover something useful from the remains? The mission of the general military surgeon is to save the lives and limbs of the wounded and the mission of the orthopædic surgeon is to follow and patch them up. The type of work done by the two is absolutely different and neither interferes with the other. Remember that 30 to 50 per cent. of the wounded require this subsequent patching up, and who else is there to do it?

Even the care of the feet is so intricate and time-consuming as to require one specially qualified to attend to it. Notwithstanding that fact most general surgeons will of necessity have far more of it to attend to than they desire. What general military surgeon wishes to travel about with a cobbler's outfit and blacksmith shop added to his kit? Yet that is what he should have if he is going to do orthopædic work. What general surgeon has the time to spend with superintending massage, and hydrotherapy and passive motions in an interminable struggle to restore stiffened fingers and other joints to some degree of usefulness? Is he willing to see that an artificial leg is made comfortable and fulfils its object? Is he willing to teach a right-handed man to use his left hand? Is he willing to educate the cripple in new fields and vocational training to earn his livelihood? If he is willing to do all of these and many others like them, then let him forsake the field of general surgery and join the great brotherhood of orthopædic surgeons. They will welcome him with open arms and his time will not only be well spent but fully occupied. If he is a good operator, so much the better. The operations he will be called to do will not be brilliant, but most scientific, difficult, tedious and painstaking, designed solely for utility and always conservative in character and requiring long-continued after-treatment with all the resources of mechanics as well as art. I trust

RELATION OF ORTHOPÆDIC TO GENERAL SURGERY

enough has been said to show that there is not the slightest antagonism between the general and orthopædic surgeon. As a rule the former has first choice and can retain such cases as he desires and the latter does not wish to have the cases that the former can attend to. The general surgeon tries to get his cases out of his wards as soon as possible but the orthopædic surgeon tries to keep them in as long as possible. One simply supplements the other, they are not rivals but co-workers. Each has his separate duties, his separate field. There is room and need for both.

Let me then plead for a cordial relation between the two—we are all working for one end, and after all it is team-work that counts.

CLINICAL OBSERVATIONS CONCERNING MALIGNANT TUMORS OF THE JAWS*

BY ALBERT J. OCHSNER, M.D.

OF CHICAGO, ILL.

It has seemed worth while to review the histories of my cases of malignant tumors of the upper and lower jaws from the standpoint of the clinician.

For the sake of convenience I have chosen one hundred consecutive histories of cases operated by me at the Augustana Hospital and have had these carefully analyzed by my assistant, Dr. Yngve Joranson, with the results shown in the accompanying tabulation. During the same time a large additional number of cases has come under my observation which were so advanced that an operation could not possibly benefit them. None of these cases were included in this series because they were not admitted to the hospital. There is, however, one observation which should be recorded concerning this group of cases, namely that practically all of them had been previously operated, and that none of them had been operated during the early part of their illness by the use of the actual cautery.

All of these histories were chosen from this one hospital because of the advantage of uniformity in the recorded account of all cases. The number one hundred was chosen because it seemed sufficiently large and because of its convenience.

The microscopic sections of every case have been preserved in the hospital laboratory, and all have been studied by myself personally in connection with my assistants.

Every case presenting itself, that seemed to have the slightest chance of permanent recovery, was operated without regard to the immediate danger from the operation, because an operative death seemed preferable to the alternative without an operation.

The actual cautery was used in every case in a most vigorous manner. In a number of cases this was repeated at several sittings. Two cases died from hemorrhage from the carotid artery where the tumor had extended into the neck and where the cauterization had reached deeper than it had seemed at the time of the operation, and the wall of the artery had become gangrenous and ruptured a week after the operation. In these cases ligation of the common carotid artery should have been made at the conclusion of the operation.

The oldest one of my cases operated by means of the cautery has lived twenty-nine years since the operation and is still in excellent health. This was a case of extensive sarcoma of the lower jaw resulting from an epulis.

* Read before the American Surgical Association, June 7, 1918.

MALIGNANT TUMORS OF THE JAWS

In this case I removed all of the molars and bicuspid teeth of the left side and destroyed the soft tissues to a distance of four centimetres in diameter and heated the bone so that about one-half of this portion of the jaw was exfoliated later, leaving enough, however, to serve as a support for the remaining portions.

I wish to direct attention especially to the value of ordinary soldering irons heated in a gas flame to a red heat for cauterizing these tumors. The tremendous heat given off by these irons seems to penetrate the deep tissues and destroy the malignant growth at a distance.

Laboratory experiments have proven that carcinoma grafts in mice will not grow after being exposed to a temperature of 160° F., and it has seemed to me likely that the heat from these soldering irons may destroy the carcinomatous tissue for a considerable distance from the point of actual cauterization by heating the tissues to a higher degree than 160° F. For this reason we leave the cautery iron in contact at each point for a considerable period of time.

Another important practical point to which we attribute a low mortality in serious cases lies in the position of the patient on the operating table and later on in bed.

During the past ten years all patients of this group have been anesthetized in the following manner: Half an hour before beginning the administration of ether, $\frac{1}{4}$ grain of morphia and $\frac{1}{100}$ grain of atropin was given hypodermically. The latter remedy prevents the accumulation of mucus in the pharynx, and the former reduces the sensitiveness to heat. The patient is then very thoroughly anesthetized with ether in the horizontal position. Then the patient is placed in the inverted Trendelenburg position with the head elevated, so that the body is placed at an angle of forty-five degrees. This causes an anæmia of the brain which will prolong the anesthesia sufficiently so that the operation can usually be completed without any additional anæsthetic. A moist gauze sponge is placed in the mouth so that blood cannot trickle down into the pharynx during the operation. If the patient shows any difficulty in breathing through the nose, large catheters are introduced through the nose into the pharynx and the patient permitted to breathe through these catheters.

In this way the patient is enabled to exhale most of the ether by the time the operation has been completed. He is then placed in a semisitting position in bed. Since introducing this plan, we have not had a single case of postoperative pneumonia in these patients, while before that time all deaths which did not result from shock, aside from the two cases of hemorrhage, were due to pneumonia.

The following data were collected from an examination of 100 cases of malignant tumor of the jaws treated at the Augustana Hospital since 1901. In considering the kind of growth present in each case, the following relation was found to hold: 67 per cent. carcinoma; 16 per cent. epulis; 16 per cent. sarcoma; 1 per cent. chondrosarcoma.

The origin of these new growths was noted and in the cases of carcinoma and epulis, the following distribution was found: 47 cases originated from the inferior maxilla; 25 cases originated from the superior maxilla; 6 cases originated from the antrum of Highmore; 3 cases originated from the cheek; 1 case originated from the parotid gland; 1 case originated from the ossis palati.

In the sarcomatous growths the examination showed that 8 cases originated in the superior maxilla; 4 cases originated in the inferior maxilla; 3 cases originated in the parotid gland; 1 case originated in the soft palate; 1 case originated in the cheek.

It will be observed that in the cases of carcinoma the majority affect the lower jaw. The cases further showed that the most usual location was in the vicinity of the molar teeth. It seems probable that here on the lower jaw, where food and débris are allowed to accumulate, at the site of the molar teeth, where tooth decay usually first takes place, an atrium of infection can be most easily established for the production of malignancy.

In reviewing the predisposing factors in connection with the origin of these new growths, as stated in the histories, it seems that the teeth play the leading rôle, and in the physical examinations it further appears that the teeth, in almost every case without exception, were either carious or loose, or else, by the addition of bridgework and crowns, afforded a breeding place for bacteria.

Irritation seemed to be the second most common exciting cause. Tobacco, either in the form of chewing or smoking, protruding bicuspid and molar teeth bruising the mucous membrane, and various other things, such as the holding of nails in the mouth, seemed to serve as irritating factors.

The frequency of occurrence of these malignant tumors in the male was found to be much lower than the percentage given by Blair. Seventy-two of the cases occurred in the male, while 28 affected the female. The percentage for the female was considerably lower in the cases of carcinoma than in those of sarcoma and epulis. Of the 67 cases of carcinoma, it was found that only 11 were female patients, while in the 33 cases of sarcoma and epulis, 17 were female patients.

As to the duration of the condition before the admission of the patient into the hospital, the following facts were determined: 25 per cent. entered before the third month; 25 per cent. of cases entered before the sixth month; 23 per cent. of cases entered before the second year; 27 per cent. of cases entered after the second year. In 65 per cent. of the cases no statement was made with regard to lymph-gland involvement. Of the remaining 35 cases, 25 showed enlarged glands.

The mortality following these operations was as follows: 3 per cent. died during the first day following operation; 4 per cent. died before the fifth day; 5 per cent. died before the twentieth day; 3 per cent. died before the fortieth day; 5 per cent. died after the fortieth day.

The total mortality of the patients while in the hospital amounted to

MALIGNANT TUMORS OF THE JAWS

20 per cent. All of these fatal cases, except two, were carcinomatous, the two exceptions being sarcomatous.

It is interesting to note that in 40 per cent. of these fatal cases, a previous incomplete operation or an excision of a piece of tissue for diagnosis had been performed. In the balance of the cases injection of iodine or oil, application of plasters or acid, teeth extraction following the appearance of the lesion, or X-ray application had been carried out.

Of the 100 cases treated in this series, 15 returned with recurrences. Ten returned once, one returned twice, and four returned three times. The permanent results of this series of cases have not been determined.

Our observations seem to warrant the following conclusions, many of which have been discussed in the works of Scudder, Perthes, Blair and others.

1. Malignant growths seem slower in making metastases in the jaws than in many other parts of the body. This is especially true of distant and general metastases.

2. Metastases occur more frequently and earlier in the course of the disease when the carcinoma is located in the lower than when located in the upper jaw.

3. The mortality in primary early operation is almost nothing; the results are exceedingly favorable. In late operations and in secondary operations, precisely the opposite is true.

4. It is of the greatest importance to destroy the growth and the adjoining tissues for a distance of two centimetres from the edge of the growth with the cautery at the original operation, because a partial operation is usually followed by inoperable metastases.

5. Malignant tumors of the jaw are much less likely to recur when removed with the actual cautery than when removed with the knife, although the latter operation may have been carried out with the same degree of thoroughness.

6. In case of deep cauterization extending to the neck, if one suspects injury to the walls of the blood-vessels, these should be ligated at the conclusion of the cautery operation.

7. It is a good rule to make the primary removal much more extensive than seems necessary, because, even then, the amount removed will be much less than what one will be forced to remove in case of recurrence.

8. The histological appearance of epulis indicates greater malignancy with each successive recurrence after repeated removal. If removed thoroughly with the actual cautery during the first operation this tumor does not recur.

9. Cases that have had teeth extracted and partial operations performed by dentists before coming under our observation have almost invariably died from inoperable metastases within two years following the original interference, especially in carcinoma of the lower jaw.

10. In sarcoma it seems best to excise the entire jaw on the side of its

occurrence. In carcinoma, on the contrary, deep destruction with the actual cautery seems to bring better results.

11. Malignant ulcers having their origin in the embryonic tooth-matrix or in the surrounding mucous membrane which have invaded the bone can still be treated successfully with permanent recovery if widely removed with the cautery, care being taken to keep the cautery iron in contact with the bone sufficiently long to destroy the deep tissues.

12. Malignant polypi of the antrum may become infected, producing empyema, thus causing the surgeon to overlook the malignancy, and resulting in a fatal delay.

13. Carcinomatous ulcers of the gums are frequently mistaken for benign, tuberculous, or gummatous ulcers, and occasionally for actinomycosis, and *vice versa*.

14. The inverted Trendelenburg position is an exceedingly valuable aid in these cases.

RECURRENT DISLOCATION OF THE LOWER JAW*

BY JOHN BAPST BLAKE, M.D.

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RECURRENT dislocation of the lower jaw is fortunately not a lesion of frequent occurrence. It may fairly be classed among the more unusual conditions which confront the surgeon; when it does happen, however, it is more than a trivial lesion—it is very painful, is apt to occur at any and all times, and requires the service of a trained surgeon for its relief. It is almost never cured spontaneously or by simple retention apparatus; and if left to itself, tends to grow steadily worse, until operation of some sort becomes imperative.

Little has been written about this dislocation, and the various operations which have been advised and recommended all have the temporomaxillary articulation for their point of attack. The suggestion offered in this paper is, briefly, to disregard the joint, but to lace or bridle the coronoid process to the zygomatic arch, either with wire or with an animal tendon of slow absorbability. This mechanically prevents opening the mouth more than a certain degree, and renders recurrence of the dislocation impossible.

Anatomy.—The temporomaxillary articulation is classed (by Morris) as a diarthrosis, subdivision ginglymoid arthrodia. The interarticular fibrocartilage which is interposed between the condyle of the jaw, the glenoid fossa, and ridge of the temporal bone, divides the joint into two separate and complete synovial cavities (except in those occasional cases in which this cartilage is perforated); of these, the upper is the larger cavity.

Besides the capsular ligaments, anterior and posterior, internal and external and lateral, there are two others of importance, the sphenomandibular and the stylomandibular, both going from the base of the skull to the inner surface of the ramus, below the joint itself.

"The chief movement of this joint is of (1) a ginglymoid or hinge character, accompanied by a slight gliding action, as in opening or shutting the mouth. In the opening movement the condyle turns like a hinge on the fibrocartilage, while at the same time the fibrocartilage, together with the condyle, glides forward so as to rise upon the eminentia articularis; the fibrocartilage reaching as far as the anterior edge of the eminence, which is coated with articular cartilage to receive it; but the condyle never reaches quite so far as the summit of the eminence. Should the condyle, however, by excessive movement (as in convulsive yawn), glide over the summit, it slips into the zygomatic fossa, the mandible is dislocated, and the posterior portion of the capsule is torn. In the shutting movement the condyle revolves back again, and the fibrocartilage glides back, carrying the condyle

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with it. This combination of the hinge and gliding motions gives a tearing as well as a cutting action to the incisor teeth, without any extra muscular exertion.

"There is (2) a horizontal gliding action in an anteroposterior direction, by which the lower teeth are thrust forward and drawn back again; this takes place almost entirely in the upper compartment, because of the closer connection of the fibrocartilage to the condyle than to the squamosal bone, and also because of the insertion of the external pterygoid into both bone and cartilage. In these two sets of movements the joints of both sides are simultaneously and similarly engaged.

"The third form of movement is called (3) oblique rotatory, and is that by which the grinding and chewing actions are performed. It consists in a rotation of the condyle about the vertical axis of its neck in the lower compartment, while the cartilage glides obliquely forward and inward on one side, and backward and inward on the other, upon the articular surface of the squamosal bones, each side acting alternately. If the symphysis be simply moved from the centre to one side and back again, and not from side to side as in grinding, the condyle of that side moves round the vertical axis of its neck, and the opposite condyle and cartilage glide forward and inward upon the glenoid fossa. But in the ordinary grinding movement, one condyle advances and the other recedes, and then the first recedes while the other advances, slight rotation taking place in each joint meanwhile" (Morris).

Scudder, Speed, Stimson, and others agree in saying that recurrent dislocation of the jaw usually demands operation. One or two of the older writers mention the injection of iodine in the neighborhood of the joint, obviously with the intention of setting up a reactive process which would favor the formation of adhesions, and so limit the excursion of the jaw by tying up the joint. Most authors, however, suggest an open operation, directed against the joint itself, and usually consisting in the removal of the interarticular fibrocartilage, or suture of this cartilage to the periosteum of the condyle; suture or reefing of the capsule is also recommended.

This operation has been done and apparently successfully, though, from a theoretical standpoint at least, the removal of the interarticular fibrocartilage might well result in increasing instead of diminishing the tendency towards dislocation, since it would remove one piece of tissue from the joint cavity, and thus remove one element which normally tends to prevent dislocation. There are, moreover, two other definite disadvantages in this procedure.

In the first place, the temporomaxillary articulation lies very deep. It is hard to reach for the purpose of careful detailed attack, as it lies deep below the surface, and is surrounded by good-sized arteries and nerves; a clear dry field is hard to obtain, and accurate work on the joint is consequently far from easy. In the second place, efforts to limit the motion of the joint, applied to the joint itself, act manifestly at poor mechanical advantage compared to forces tending towards hyperextension; the latter

RECURRENT DISLOCATION OF THE LOWER JAW

act on the chin or body of the jaw, and by leverage which becomes more and more powerful according as the dislocation force is applied further and further from the joint. In the classical operation, we are trying to oppose this powerful leverage, by a plastic on the joint itself. It is obvious, therefore, that even if the operation does tend to diminish the chance of dislocation (which seems questionable), it is working at a decided disadvantage mechanically to trauma and muscular action.

The probable reason that the operation has been successful in the past is that whatever else it has accomplished, it has caused a large mass of scar tissue to form in relation to the joint, has partially destroyed the joint, and by virtue of the retentive bandage applied after the operation, and sometimes worn for weeks, has given the scar time to grow firm without being subjected to stretching; this materially tends to limit the range of motion in the joint, hence makes subsequent dislocation less likely.

In view of this, it is strange that tying up the coronoid process or the tissues inserted upon it to the zygoma, has not been suggested before. Perhaps it has been recommended, but I am unable to find any reference to it. This procedure is less difficult than any careful and accurate work on the joint itself, and further, it acts to a much greater mechanical advantage, in that the coronoid is 3 or 4 cm. in front of the joint and is by so much in a better position to withstand trauma tending to dislocation. With this in mind, the following operation was devised and performed.

The patient, a man of twenty-seven, was rather a pugnacious individual; he had frequent and violent physical contact with his fellow-men; during these gentle passages at arms, he suffered dislocation of the jaw not once, but many times, and on rapidly recurring occasions.

As a result of this, he gradually became unable to laugh without dislocation; nor could he yawn without the same inconvenient occurrence. When I saw him, he could not even sleep (especially if, as often happened, he took a few social glasses as nightcaps) without imminent danger of waking to find his mouth wide open and his chin fixed upon his chest, and being compelled to seek immediate surgical aid. It was asserted that his dislocated jaw was reduced at the Boston City Hospital Relief Station, near which he lodged, at least forty or fifty times, sometimes more than once in a single night. In spite of the frequency of the lesion, which was bilateral, he never was able to reduce it himself. He had tried bandages, but possibly did not wear them long enough for a fair trial; operation was obviously the only form of treatment that offered hope of success. After careful examination, I was impressed with the disadvantages of attacking the joint itself in a condition so marked as this, and remembering the familiar method by which the lower jaw-bone is held to the skull in the mounted skeleton (a spring tacked above to the temporal bone and below to the coronoid process), I was struck with the idea that something of this nature might be effective; that is, that the coronoid process be bridled to the bony skull, and the zygomatic arch suggested itself, at a glance, as the obvious anchorage.

The patient agreed to the operation, understanding that he must assume some chance, since there seemed to be no precedent for the procedure. An incision was made along the lower border of the zygomatic arch and the fibres of the masseter separated from it. This incision was well above Stenson's duct and is parallel to the facial nerve fibres. With some difficulty, the coronoid process was reached; it was much deeper than had been anticipated, and I was not able to do what I had originally planned; this was to drill through the tip of the coronoid, thread a piece of silver wire through the hole and lace this over the zygoma. I therefore looped the wire first over the zygoma and then brought it down and carried it through the insertion of the temporal muscle, and the periosteum on the front of the coronoid, twisted the ends together, flattened it, and closed the wound without drainage. The wire loop was long enough to allow the jaw to open for 2 cm., or one inch between the incisors. The masseter was carefully sutured to its origin; bandages held the jaw closed, and the wound healed by first intention. The jaw was immobilized three weeks, probably longer than necessary. For some time the patient either could not or would not open the teeth more than 1 cm., saying either that it hurt or that he was still afraid it would slip. Gradually confidence and a wider range of motion returned. Now more than a year after the operation, his jaw is normal and reliable in every way, the excursion being about 4 cm. at the incisors. The X-ray shows that the wire has twisted from its original position, but it does not cause any discomfort, and gives a mental sense of security to its somewhat excitable and erratic possessor.

NOTE.—Since this paper was written, the patient applied for examination for the army: he told the examining officer that the wire caused him pain. This pain was considered sufficient cause for rejection. The patient told me, however, that he did not complain of pain, but was rejected because he could not open his mouth widely. The mouth can be opened sufficiently for thorough mastication and the pain is undoubtedly imaginary. From a surgical standpoint, the writer cannot believe that the patient's condition is inconsistent with any duty of a soldier.

I should certainly try this method again on similar cases. I am inclined to think that on the next occasion, I should use kangaroo tendon or chromic gut instead of wire, though I am not quite certain on that point. I should not waste time trying to drill the bone, but should go directly through the structures on the front of the coronoid process, and should not immobilize the parts for more than two weeks. Careful suture of the masseter is essential, both from the point of strength and of cosmetics.

Blair has suggested banding two opposing teeth and then tying the bands together with silk gut; in early cases which had recurred but a few times, this might perhaps be sufficient. Injections of iodine are not indicated.

CONCLUSIONS

Recurrent dislocation of the jaw should be treated by operation. The coronoid process, or the insertion of the temporal muscle into it, should be

RECURRENT DISLOCATION OF THE LOWER JAW

tied up the anterior part of the zygomatic arch. This may be done with silver wire, or with slowly absorbable suture material. The operation, though not so easy of execution as it seems on paper, is less difficult than the attack on the temporomaxillary joint, is much more logical, and more mechanically efficient: it does not injure important structures, and the scar is not disfiguring. The result should be one hundred per cent. success.

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TWO CASES OF ENLARGED THYROID PRODUCING SUFFOCATION BY DISPLACEMENT BENEATH THE STERNUM

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THE two cases herewith reported seem to be unique. We have failed to find any reference in literature to any similar condition. That a cervical thyroid might become displaced and result in death seems hardly possible, but in one of the cases here reported that did occur.

CASE I.—Wife of a physician, twenty-four years of age, for several years was known to have an enlarged thyroid and with it many of the regular nervous symptoms. One evening, in 1905, while at dinner, she choked and her husband noticed that she was cyanosed and was making strenuous efforts at breathing. On approaching he noticed a change in the contour of the neck; where there had been an enlargement, there was now a depression. Immediately grasping the situation, he placed the patient prone with the head down and hip elevated, and made forcible pressure over the chest. There was an almost immediate slipping of the tumor back to its normal position, with complete relief of symptoms. The patient has remained well since that time and has never consented to operation.

CASE II.—A woman thirty-eight years of age, Russian, had suffered from the presence of an enlarged left thyroid for six years. She had been advised to be operated but refused.

On the evening of May 10, 1917, she was seized with dyspnoea and pain in the region of the sternum, following an attack of coughing. Dr. L. B. Cohen was called to see her a half hour later, and found her cyanosed, breathing with great difficulty and the pulse very rapid and feeble. I was called in consultation and arrived about half an hour later but found the patient had died about fifteen minutes before my arrival, this being about forty-five minutes from the onset of the attack.

Examination revealed a marked cyanosis of the face and neck and of the entire left upper extremity. The left side of the neck was flattened, the tumor which had been present for six years had disappeared and the upper edge of it could be felt just behind the clavicle and sternum.

Although strongly urged the Coroner would not order an autopsy.

These cases seem similar in all respects. In the first life was evidently saved by the husband being immediately at hand and correctly diagnosing the condition.

It is quite evident that the enlarged gland, in one case by choking, and in the other by coughing, was drawn down from its place in the neck behind the unyielding sternum and clavicle, and there pressed upon the trachea and

POSTSTERNAL GOITRE

important blood-vessels. In the second case it was evident that the return circulation from the left upper extremity had been completely shut off.

Why and how this condition can be produced it is impossible to say.

The dangers of such an accident should be borne in mind and probably no better procedure could be adopted than that which was used in the first case mentioned.

It is not very uncommon to find an enlarged thyroid gland extending beneath the sternum and producing marked symptoms. In both these cases the thyroid was entirely in the neck until during violent exertion it became dislocated beneath or behind the sternum.

AN APPLICATION TO EMPYEMA OF THE PRINCIPLES UNDERLYING THE USE OF ANTISEPTICS

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ON this occasion it has seemed to me best to give a clinical trend to my remarks. The opportunity to do this has come through experiences acquired in association with other officers of the Medical Reserve Corps in the antiseptic treatment of cases of empyema in a Base Hospital in one of the Cantonments of the National Army. In this way, I hope to avoid a too strictly academic mode of presenting the subject.

Briefly stated, laboratory experiments have shown that the three primal factors in the progress of disinfection are: Contact, mass and time, the first being made absolute, the two latter correlated. In these respects the process of disinfection is closely analogous to a simple chemical reaction, the antiseptic and bacterial cytoplasm constituting the reacting substances.

In clinical practice much more than mere deductions from the foregoing almost self-evident generalizations must be taken into consideration. Individual antiseptic substances differ greatly in speed of action, toxicity and the range of reactions they may enter into other than those upon which their germicidal potency rests. All these properties may seriously affect their surgical usefulness as well as determine the modes in which they can most efficiently be employed.

The cases of empyema to which I have just referred resulted from infection with the hæmolytic streptococcus and were most frequently secondary to measles and a somewhat unusual type of bronchopneumonia. Such empyemata differ considerably from those occasioned by the pneumococcus in severity and persistence and present a difficult problem in disinfection.

The pleural exudate is abundant. At first serous or serofibrinous, it rapidly becomes purulent. There is a fibrinous deposit of considerable thickness upon the pleural surfaces, which persists after suppuration has become established and, at autopsy, presents a shaggy fibrinopurulent coat not readily detached from the underlying structures.

The number of microorganisms in the exudate is very great. Sometimes as many as 10,000,000 have been observed in a single drop and from two to four millions are frequently present. Very rarely is there any evidence of local immunity. The leucocytes in the exudate are usually necrotic and only occasionally are there indications of a moderately effective phagocytosis.

The cavity occupied by this exudate may have a capacity of one or two litres and a configuration of considerable irregularity due to the coalescence of previously separate pockets or the presence of pre-existent adhesions. Access to this cavity is usually secured by the resection of a single rib.

It is obvious that the conditions presented by these cavities oppose great difficulties to be overcome in attaining satisfactory disinfection. There is

USE OF ANTISEPTICS IN EMPYEMA

no opportunity to effect a mechanical cleansing such as would be the first step in open wounds accessible to direct surgical intervention. Even to secure perfect drainage is a problem requiring careful individual attention in each case, and is frequently a matter of uncertainty, owing to the difficulties of exploration.

To overcome with antiseptics a massive infection under the circumstances just outlined, it is important that the agent used should act quickly, since the abundant discharge tends to both dilute and remove any application. It should neither occasion precipitates with constituents of the exudate nor have a hardening effect upon fibrin. And it should not be toxic.

The members of the chlorine group of antiseptics offer better promise of completely meeting the requirements than any other substances with which we are familiar. But, for their effective application certain definite conditions must be met. Active chlorine, to which these substances owe their antiseptic value, is not a specific germicide. It reacts with many substances invariably present in exudates and these reactions materially reduce or may even entirely abolish the germicidal action; the chlorine passing into more stable and inert combinations. Contact with the exudate may so reduce the mass of antiseptic that the time during which it can act is insufficient for adequate germicidal effects. This is what actually occurs in practice when treatment is begun in these cases. The very reactivity upon which the value of these compounds as germicides depends curtails the time during which they exert this action.

There are three active chlorine compounds available for use in surgical practice: neutral sodium hypochlorite or Dakin's solution, chloramine-T and dichloramine-T in an oily solution prepared with chlorcosane as a solvent. The permissible concentrations in which these can be used without undue irritation differ. Half of one per cent. is the limit for the hypochlorite, two per cent. or thereabouts for chloramine-T, and from 5 per cent. to 8 per cent. in chlorcosane for the dichloramine-T. The hypochlorite is, therefore, available in least concentration. It is also the most rapidly reactive of the three and, in consequence, most transient in its action. There is, however, one consideration which makes it of greater value in the treatment of these empyemata than either of the chloramines. This is its markedly favorable influence upon the dissolution of fibrin. This action also entails the loss of active chlorine and we return once more to the necessity of maintaining the mass of applied antiseptic in order to attain satisfactory disinfection.

Since, in the use of sodium hypochlorite, the mass of antiseptic cannot be continuously increased by raising the concentration of the solution employed, this must be accomplished by fresh additions in quantity exceeding at any given time the rate at which the substances rendering the chlorine inert accumulate in the exudate. During the first day or two this may require an hourly instillation of as much as 100 c.c. of Dakin's solution, distributed as completely as possible to all parts of the cavity by means of Carrel tubes. When such quantities are used, it is important to provide a drainage tube for the reflux. The progress of disinfection is greatly facili-

tated by a thorough irrigation with the solution at intervals not exceeding 24 hours, for this removes any large accumulation of reactive substances that may exist in the free fluid.

The progress of disinfection can be followed very satisfactorily by inspection of the dressings and the return during irrigation or by direct bacteriological examination with smears or plate cultures. The first effect is the abolition of odor in those cases in which there was a foul discharge. Until this is accomplished, there is very little apparent effect upon the purulent character or the amount of the exudate. Neither is the bacterial content materially affected. But after a day or two the amount of pus diminishes and there is less secretion from the wound.

Subsequently the character of the discharge undergoes a striking change. The pus either entirely disappears or is present in very small amount and the secretion becomes viscid, mucoid and transparent, resembling uncooked white of egg. A day or two later this also disappears and there is then little if any discharge. At this stage it is very difficult to cultivate micro-organisms from the contents of the cavity, for it is substantially sterile. In no case could hæmolytic streptococci be detected. If the cavity is now irrigated with Dakin's solution and the patient coughs or blows against resistance, there is good evidence of lung expansion even in protracted cases and repeated coughing causes the appearance of traces of blood in the outflowing fluid.

Considerable interest attaches to the appearance of the mucoid material, increased freedom with which the lung expands, and the slight hemorrhage. The viscid substance responds faintly, but distinctly, to tests for active chlorine and appears to be a chlorinated product of fibrin. Its presence can probably be attributed to the action of the hypochlorite upon the fibrinous deposit on the pleural surfaces, an action which comes prominently into play only when there is little pus to consume more rapidly the available supply of active chlorine. The trivial hemorrhage induced by moderate disturbances is in harmony with this supposition. Observation at autopsy of a bilocular cavity in which only one division was accessible to adequate treatment with Dakin's solution also offers confirmatory evidence. The pleural surface of the treated cavity was covered with thin granulations, while the untreated portions were heavily coated with a shaggy fibrinopurulent deposit.

Pleural surfaces, free of fibrinous deposit but covered with fine sterile granulations, are in condition to unite with the formation of desirable adhesions if they can be kept in contact for a moderate length of time. A limited experience makes it probable that the lung under these conditions spontaneously tends to expand, but that this can be hastened by the use of a flutter valve, bottle-blowing, deep breathing and other procedures.

Infection of the pleura in the cases under consideration is probably invariably secondary to a pulmonary infection and in at least many cases an intermediate lesion is a subpleural abscess. This may be minute or of considerable size. In the latter event, perforation into the pleural cavity may lead to a communication with a bronchus. This precludes irrigation

USE OF ANTISEPTICS IN EMPYEMA

of the pleural cavity with Dakin's solution, but cautious intermittent instillation frequently occasions no inconvenience.

Attention need, perhaps, hardly be called to the fact that the foregoing treatment with Dakin's solution must be unremittingly maintained to attain the most satisfactory results. If the supply of active chlorine be too greatly interrupted before adequate disinfection is accomplished, there is certain to be a retrogression of the process.

It is possible to substitute a 5 per cent. solution of dichloramine-T in chlorcosane for Dakin's solution, making the application once or twice in 24 hours after irrigation with sterile saline or a weak aqueous solution of chloramine-T. The oily solution of dichloramine-T is not irritating to the walls of the cavity, though, like Dakin's solution, it not infrequently affects the unprotected skin where there are no secretions appropriating the active chlorine. Disinfection appears to be somewhat less rapid and the removal of fibrin a degree less satisfactory than when the hypochlorite is used. But that the fibrin does come away is evident, for thin sheets of considerable area may be easily detected in the discharge and are frequently so abundant as to clog the drainage tubes. Where facilities for the proper application of Dakin's solution are not at hand, it will be much more satisfactory to employ dichloramine-T as entailing less apparatus and unremitting care. The mass of antiseptic introduced at a time may be many times greater without injury, since it comes into play gradually as it passes from the oil only to maintain a moderate concentration of active chlorine in the aqueous medium.

Under favorable conditions it is reasonable to expect sterilization of an uncomplicated empyemic cavity with Dakin's solution in from five to ten days. To accomplish this the cavity must be accessible to the antiseptic throughout its whole extent and the mass of antiseptic introduced must be sufficient to exert a reasonably persistent action over a period required for disinfection in spite of concomitant reactions. Many of the latter are desirable. Among such are the deodorizing and detoxicating action of the chlorine compounds as well as the effect of hypochlorite and to somewhat less extent of dichloramine-T on fibrin and necrotic tissue.

Although it appears essential for the rapid relief of the local condition in these empyemata, the antiseptic treatment of the pleural cavity does not meet the full needs of these patients. Their nutritive requirements are very great. This is shown by the rapid loss of weight and strength on ordinary diets. A very limited study has demonstrated a loss of nitrogen which may amount to 23 grammes a day. How can one look for the development of a general immunity on nitrogen starvation?

The nitrogen of the body can be conserved by raising the calorific value of the food taken. To bring the patients into nitrogenous equilibrium from 3000 to 3500 calories are required. These may be supplied in the form of readily assimilable carbohydrates as well as fats and proteins. The addition of milk sugar to eggnog, cocoa or other beverages is a convenient way to augment the calorific intake.

HEMORRHAGE FROM AN ANEURISM OF THE INTERNAL CAROTID ARTERY, FOLLOWING SEPTIC SORE THROAT*

By JOSEPH RANSOHOFF, M.D., F.A.C.S., F.R.C.S. (ENG.)

OF CINCINNATI

HEMORRHAGE has always been regarded as one of the most serious complications of phlegmonous processes. This is particularly true of those situated in the neck. Whether it occurs in the course of an angina Ludovici, the post-scarlatinal infection of the throat, or a retropharyngeal septic lymphadenitis or peritonsillar abscess, the bleeding is very apt indeed to be quickly fatal.

It has long been known that these hemorrhages almost invariably are arterial in character, rather than venous, because intravenous pressure is insufficient to overcome the pressure from without and agglutination of the vein with life-saving thrombosis results. Exceptions, of course, occur, and the carotid artery has been tied for hemorrhage, following a septic process of the throat, which autopsy showed to have been due to an erosion of the internal jugular vein. This was a case of malignant tumor in which a ligature was loosely thrown around the carotid as a prophylactic against impending hemorrhage. The ligature was subsequently tied. The patient died the following day of hemorrhage from the jugular vein (Beck¹).

In a case of the late Doctor Dandridge, occurring in the Cincinnati Hospital, of a shot wound of the upper part of the neck, which entered with an infection, the common carotid artery was tied for hemorrhage. The autopsy revealed a wound of the vertebral.

While hemorrhage from the internal carotid, as the result of ulceration of the artery, is alluded to by all classical writers upon the subject, the cases are fortunately far from common.

Newcomb² ten years ago was enabled to collect 51 cases following quinsy and allied conditions, from a widely distributed literature, extending over a period of over fifty years. This is not a large number, and it is likely that not a few quickly fatal cases have not been reported because there was no time for surgical intervention. In view of the comparative paucity of these cases, it is remarkable, I believe, that I have seen two of them within three months of each other. Both in young subjects, one with a quickly fatal result, the other fortunately saved by the pathological condition, which permitted a timely diagnosis.

CASE I.—The fatal case was that of a lad of seventeen years of age, who had a peritonsillar septic inflammation of the throat, which invaded the retropharyngeal lymphatic, and caused an abscess. The temperature rose to nearly 105°, with corresponding rapidity of pulse-rate.

* Read before the American Surgical Association, June 9, 1918.

ANEURISM OF THE INTERNAL CAROTID

The abscess opened spontaneously, and later the opening was dilated with a forceps. The temperature quickly subsided and it and the pulse-rate were normal a week after the inception of the trouble. Notwithstanding this favorable expression of the general condition, the discharge from the opening in the pharynx was, as I understand, extremely fetid. On the evening of April 21st, following an excellent day, hemorrhage suddenly came from the carotid artery and proved fatal in a very few minutes. It was only when this hemorrhage supervened that I was asked to see the case.

Fearing the possibility of such a hemorrhage, the nurse had been instructed to compress the common carotid artery, but her efforts in this direction proved of no avail. In this case there was no evidence of arterial erosion until the fatal hemorrhage occurred. In the majority of cases fortunately, the bleeding recurs from time to time, and an opportunity is thus given to permanently and successfully cut off its source by timely ligation.

CASE II.—The second case was that of a girl, sixteen years of age, seen with Doctors Rachford, Dreyfoos and Iglauer. She was admitted to the Jewish Hospital, January 20, 1918. For two weeks previous to admission she had suffered from a septic sore throat. The temperature varied from $101\frac{1}{2}$ to 105° . The white count varied between 14,600 and 20,000, attended with 75 per cent. polymorphonuclear, 7 per cent. small lymphocytes and 12 per cent. large lymphocytes and 6 per cent. mononuclears. Besides the condition within the throat there was a great deal of swelling in the glands of the submaxillary triangle of the left side, which because of a matted condition indicated an extensive peradenitis. There was noticed at this time a very decided narrowing of the left palpebral fissure and of the left pupil, the very characteristic signs of pressure on the cervical sympathetic cord.

The abscess was opened eight days before admission and the temperature seems to have subsided somewhat, but it continued irregular between 100 and 104, with the pulse-rate varying from 122 to 130. Three days before admission to the hospital a very slight hemorrhage came from the drainage opening in the pharynx, but this subsided spontaneously. This recurred with great severity on the day of admission. The temperature continued high, the patient was put under gas oxygen anæsthesia, and the infected glands in the neck were removed. When the throat was then examined it was found that the quite severe hemorrhage, which had occurred during the morning, was due to an aneurism of the internal carotid artery. The examining finger detected in the posterolateral wall of the pharynx a swelling as large as a peach, elastic, distinctly pulsating and easily recognizable as an aneurism, from which recurrent hemorrhage had come. Compression of the common carotid caused the pulsation to disappear. Since, if for no other reason, because of the inflamed condition in the neck, it would have been impossible to tie the internal carotid artery, it was determined to tie the common carotid. The operation was performed at the point of election, but before the artery was tied it was compressed for five or six minutes, the patient being permitted to come partly from under the

influence of the anæsthetic, to determine as far as this might do it, whether coma or paralysis would result from the tying. Nothing of either nature appearing, the artery was divided between two ligatures. Considerable dyspnœa (due to encroachment of the hæmatoma on the larynx) which was present before the operation, seemed to grow worse after this, so that in the afternoon a tracheotomy under local anæsthesia was done. From this time the patient made an uninterrupted recovery. Three months after the operation the patient was perfectly well. There was no return of pulse in the temple, and the eye symptoms had entirely disappeared.

When hemorrhage comes from the ulceration of an artery from within the throat, it usually follows soon after the abscess has opened spontaneously or been opened. The reason for this is that with the sudden release of pressure on the vessel wall from the opening of the abscess, the weakened area of the artery gives way with the continuance of the pressure within. The suspicion may therefore arise that damage was done to the artery by unskilful use of the knife; the operator ignoring the close proximity of the carotid to the pharyngeal wall. Indeed, the surgeon himself may feel some qualms as to his responsibility for the arterial hemorrhage. This is shown to be unwarranted by the statistics of Newcomb, according to which there were 7 immediately fatal hemorrhages from ulceration of the internal carotid, in which the abscess had not been opened. There were also fifteen cases of secondary hemorrhage, following the spontaneous opening of the abscess. In all of these the hemorrhage was recurrent. Seven of these cases recovered. In a number of these recoveries no operation was performed, so that it may be questioned whether the internal carotid was really invaded.

The diametrically opposite end-results in these two cases can easily be accounted for by the fact that in one case a false aneurism was formed and that in the other the bleeding was so profuse from the moment the artery gave way that there was no time for such formation. The second case is interesting because aneurisms of the internal carotid, even of the false type, that are not intracranial are very uncommon. The intracranial variety as evidenced by pulsating exophthalmos are not at all rare. Of one thousand ligations of the common carotid, 113 were for pulsating exophthalmos. The extracranial internal carotid aneurisms, on the other hand, are exceedingly rare. According to an article by Shipley and Linn,³ all carotid aneurisms (and the literature has been gone over very carefully), the great rarity of extracranial internal carotid aneurisms is emphasized.

According to Bobbio,⁴ there were only 18 cases of aneurism of the internal carotid to be found in the literature. The common carotid was tied 11 times in these cases, with five deaths. According to Matas, these aneurisms are very rare and when they do occur, they are often mistaken for other conditions with fatal results. Of 11 cases collected by Werner, only six were correctly diagnosed before treatment. The case reported,

ANEURISM OF THE INTERNAL CAROTID

without question, belongs to the class of erosion aneurisms, described by Matas.

In the treatment of aneurisms of the extracranial internal carotid the cases must be extremely rare in which any other treatment than the tying of the common carotid artery would be applicable. I believe no case has been recorded in which aneurismorrhaphy has been attempted. In such a case as the one reported, the preliminary operation for exposing the aneurism would, of necessity, be a very extensive one, necessitating the temporary resection of the inferior maxilla. There would even then be practically insufficient room for the treatment of the sac, or for the closure of the eroded artery. While it may be practical in some of these cases to tie the internal carotid rather than the common carotid, it was not favorable in the case reported on account of the condition of the cervical glands. Furthermore, there would be no signal advantage in a case of this kind in tying the internal carotid, since a great danger, of course, would still be from cerebral anæmia.

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POST-OPERATIVE THORACIC DRAINAGE *

BY WILLY MEYER, M.D.

OF NEW YORK

It is natural that in the course of operations within the thorax, same as in other parts of the body, conditions arise, or such pathologic affections are encountered, that drainage becomes indicated. Yet, for quite a time it was not carried out on indication, but, on the contrary, strongly advised against, owing to the inevitably resulting, often fatal, pneumothorax.

Right here it should be stated that pathologic affections of the pleural sac as such—primarily among them "empyema"—are excluded from this discussion. The treatment of purulent inflammations of the pleura occupies a place of its own in operative surgery, and does not, strictly speaking, belong to what is generally designated as "thoracic surgery." The latter term refers to surgical attacks upon organs situated within the thorax, *beyond* the pleural sac, though the latter, whether in its normal physiological, uninflamed, "virgin" condition, or, chronically inflamed and more or less adherent to the lung, but still representing the greater portion of a free pleural cavity, has to be traversed. In other words, the class of thoracic cases considered in this paper as requiring subsequent drainage comprise operations upon the lungs and bronchi, the œsophagus, heart with aorta and pulmonary artery, and mediastina, as also upon organs of the abdominal cavity if attacked through chest and diaphragm, *i.e.*, cases of transthoracic laparotomy.

At our hospital the problem of avoiding a post-operative acute pneumothorax as the result of drainage was solved in the following manner: ¹

After hermetically closing the thoracic incision and providing for free drainage of the chest at the most dependent place of the pleural cavity, these patients were placed under differential air pressure (first case, May, 1911). (1) By this procedure their lungs were kept distended. That is to say, before closing the thoracic incision by means of layer sutures, a stab was made in the ninth or tenth intercostal space and within the scapular line, long enough to allow two split rubber tubes and a cigarette drain to pass through it easily. The intercostal stab wound—dressed with a split piece of sterile gauze—plus projecting drainage tube ends, were covered with a large piece of sterilized rubber dam. To hold the latter in place, its borders were made to adhere to a layer of zinc ointment which had been liberally spread over the immediate neighborhood of the drainage hole. When the patient was allowed to breathe again under normal atmospheric air pressure—usually after fifteen to eighteen hours—the piece of rubber dam performed, I believe, a very important task: It acted as a valve, allowing secretions to escape from within

*Read before the American Surgical Association, June 7, 1918.

¹ Willy Meyer: "On Drainage after Intrathoracic Operations with Special Reference to the Œsophagus." *ANNALS OF SURGERY*, 1912, vol. lvi, p. 100.



FIG. 1.—Special bed for drainage, thirty inches wide. Height corresponds to positive pressure apparatus. Mattress projects above end frames. Large rubber-tired wheels; brake for two.

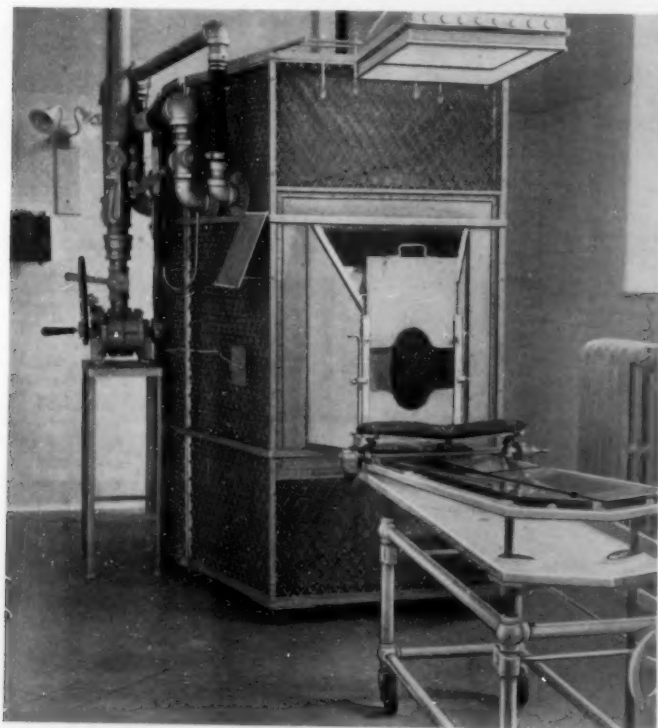


FIG. 2.—Positive pressure cabinet at the thoracic pavilion of the Lenox Hill Hospital. It was photographed with one of the operating tables in front of it.

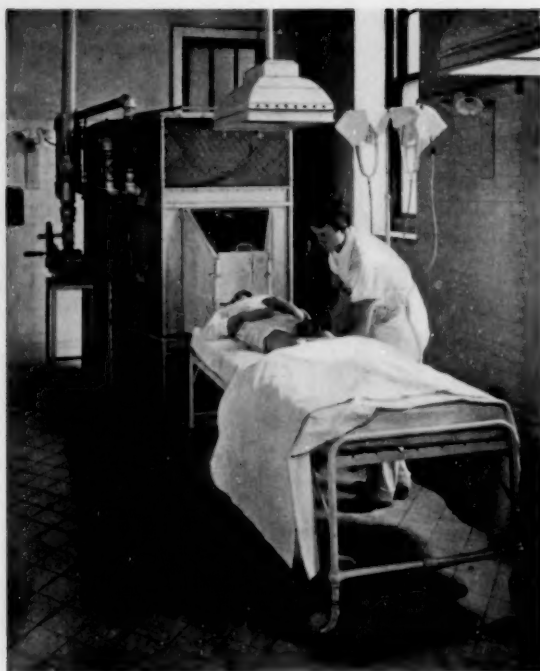


FIG. 3.—Patient in place for after-treatment with free drainage of the pleural cavity under positive pressure. Note the nurse inside the cabinet ready to carry out instructions; outside the patient can undergo any kind of after-treatment which may be deemed advisable.

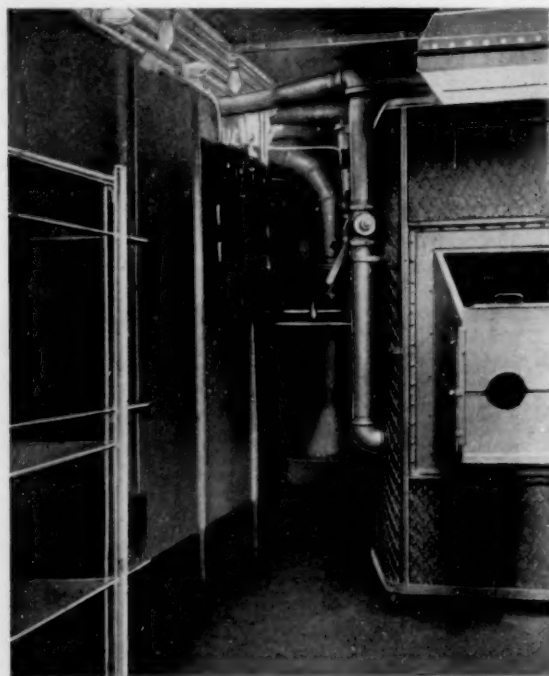


FIG. 4.—A view of the interior of the negative chamber at the pavilion for thoracic surgery, Lenox Hill Hospital, New York, N. Y.



FIG. 5.—Patient ready for an intrathoracic operation in the chamber. The special operating table has been supplied with removable side flanges which widen it sufficiently so that a mattress can be placed upon it for after-treatment under negative pressure. The anaesthetist, or nurse, and the patient's head are inside of the positive cabinet which stands within the chamber.

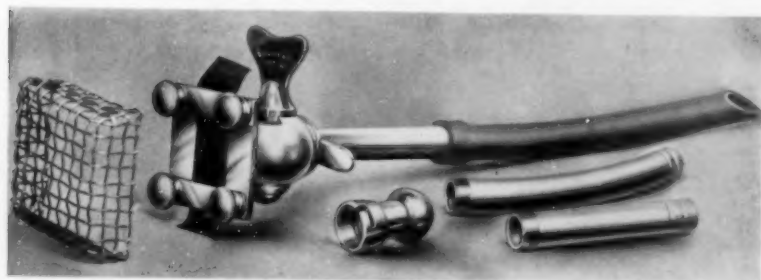


FIG. 6.—Tiegel's thoracic drain.



POST-OPERATIVE THORACIC DRAINAGE

outward into the dressing, but preventing air from entering the thorax along the drains.

The method proved eminently successful, provided the patients were not removed from the apparatus too early and the rubber dam had been properly placed. But it was cumbersome and expensive, two special nurses being required to be on duty simultaneously during the first twenty-four hours and then alternately for the second twenty-four hours, during which latter the patient was placed in one of the so-called "recovery rooms" of the thoracic pavilion of the hospital, in order to give us an opportunity to determine whether he could be safely moved back, either to the ward or his private room.

From the operating table the patient was conveyed to a bed specially constructed for the purpose (Fig. 1). As will be seen, its frame has no back and it is of the same height as the opening which allows the patient's head to pass into the positive pressure cabinet (Fig. 2).² A nurse is permanently within the latter, while a second one administers to the patient's needs without (Fig. 3). One of the duties of the outside nurse is to reduce the pressure to 1-1½ mm. every half hour in order to avoid overtaxing the heart muscle with the continuous higher air-pressure of 5 to 6 millimetres. She also is required to carry out artificial respiration with the apparatus at regular intervals, a procedure which represents the best known heart stimulant on a physical basis. Arrangements have been made to carry out the same kind of after-treatment within the negative chamber (Fig. 4), likewise for the purpose of avoiding overstrain of the heart muscle. The latter variation has not been tried as yet. Fig. 5 shows a patient in the negative chamber ready for operation. It gives an idea of how a patient should be placed in it with due regard for the contemplated after-treatment, viz.: on his back.

2. Almost simultaneously with the publication of this mode of draining the thoracic cavity, another method appeared in print, namely, that of Tiegel, then of Dortmund, Germany (*Centralbl. f. Chir.*, 1911, No. 10). He constructed and tested a drainage tube made of flexible metal, which carried as a prolongation of its end—within the thorax—a rubber tube. It had a rubber valve at the outer end, covered by a wire frame (Fig. 6). The latter took care of keeping up the action of the valve by holding off the dressing which buried the tube. It was usually left in one angle of the thoracic incision, or introduced through a special stab. Tiegel saw satisfactory results from the use of this valve drain. Personally, I have never tested it.

3. Remembering the all-important principle in thoracic operations of simplifying as much as possible the required work, in order not to have this chapter of operative surgery take an exceptional place, and yet always strictly observe the factors of safety, the author searched for a long time for a method of post-operative thoracic drainage which would not only allow the patient to be returned from the operating room directly to his bed, but at the same time permit of air-tight closure of the wound. Incidentally, the

² Regarding the further details, cf. *ANNALS OF SURGERY*, loc. cit.

method would of course have to afford security from the occurrence of a post-operative acute pneumothorax.

On studying the recent literature with this point in view, the author came across Kenyon's method of draining empyema in children (Johnson's "Operative Therapeutics," vol. i, p. 242), which consists briefly in the following:

After proper local preparation, the aspirating needle proves the presence and location of the pus. It is left in place. Alongside the same a narrow-bladed knife is inserted between it and the upper margin of the rib below, until it penetrates the pleural cavity. A short incision is made, the knife withdrawn and replaced by an artery clamp. After removal of the needle, the branches of the clamp are spread and the drainage tube crowded in. It passes through a button-holed piece of tape which is fastened to the chest-wall with adhesive plaster and prevents its slipping out, while a rubber cuff over the tube takes care of its not slipping in further. The end of the tube is connected with a bottle underneath the bed same as when draining other cavities of the body. The accompanying illustration, taken from Kenyon's article, nicely brings out the various points in question (Fig. 7).³

The author decided to try and adapt this method to the needs of thoracic surgery in operations on organs situated *beyond* the pleural cavity. After repeated conferences with Doctor Kenyon, it was considered best not to make any material change, but test the essentials of the method at the next opportunity. The latter presented in a case of resection of the œsophagus for carcinoma, done at the Post-Graduate Hospital under intratracheal insufflation, on December 17, 1915. As the author desired to drain the bed of the œsophagus after resection in the posterior mediastinum, by means of a long cigarette drain, provisions had to be made that the latter could pass through the Kenyon drain. It was therefore decided to make use of a flattened metal tube (with inside fenestra), through which the cigarette drain could be passed; it was fastened at the outer end of the tube by a special arrangement.

The curved incision surrounding the scapula, with division of five ribs at their angle (Torek), was used. As usual, the proximal portion of the œsophagus was brought out at the neck and transplanted antethoracically, beneath the skin. Kenyon's drain was placed as in method 1 (see above), viz.: through a special stab in the tenth intercostal space, in the scapular line. The tumor was firmly adherent behind the aortic arch which latter had to be mobilized. During resection it was found that the growth had penetrated beyond the œsophageal wall into the posterior mediastinum. Ligation of the vena azygos became necessary. The shock, consequently, was great. The

³ In No. 1 of the *Centralbl. f. Chir.* of 1916, Schmerz, of von Hacker's clinic in Graz, publishes a new method of treatment of empyema, the principle of which is very similar to that of Kenyon's method which was published in 1915 and first tried in 1910. Schmerz's procedure is more cumbersome, in so far as he perforates the rib and inserts a rubber drainage tube with v. Hacker's method of stretching the tube over a probe. If the consistency of the contents require a tube of larger size, a portion of rib is resected and a perforated rubber cork with a glass tube fitted in.

POST-OPERATIVE THORACIC DRAINAGE

patient lived but a few hours. However, it was observed to our greatest satisfaction that on raising the head of the bed, the air which had been left behind within the thorax when suturing the incision bubbled out into the water of the bottle placed beneath the bed, synchronously with the patient's respiratory movements, until the lung evidently had become completely expanded. Incidentally, bloody secretion was observed to enter the water in the drain bottle in greater quantities. It was distinctly seen in the interposed glass tube how a column of water in the drainage tube that hangs down into the water within the siphon bottle raised and fell with respiration.

The method had stood the test well and it was decided to continue its use.

Quite some time elapsed before the next appropriate case came to hand. For the drainage in this case it was planned, after consultation with Doctor Kenyon, to substitute a rubber tube for the metal tube formerly used, and



FIG. 7.—Baby suffering from empyema, with Kenyon's drainage started (taken from Kenyon's article).

make it pass through a central hole in a slice of cork, this hole having a slightly smaller diameter than the rubber tube (Fig. 8). Both cork and tube are sterilized by boiling.

CASE II.—Recent case of bronchiectasis of left lower lobe. Incision of free pleural cavity for exploration; closure of the incision and drainage of the chest by means of Kenyon's method. Immediate pneumotomy. Recovery.

J. L., male, thirty-two years old. Lung suppuration following pneumonia of left lower lobe in the summer of 1916; sputum often foul; some blood; quantity: 100 to 150 c.c. in twenty-four hours. X-rays and bronchoscopy corroborate the diagnosis.

Operation (January 11, 1917).—Pharyngeal insufflation (Doctor Branower). Intercostal incision in seventh interspace, curving upward

posteriorly, enters free pleural cavity; hand introduced locates adhesion of lung posteriorly parallel with spine. Aspiration in paravertebral line over the adherent portion, thus made out, finds pus about two inches below surface. It is decided to close the free portion of the pleura with Kenyon's drain in place and then do pneumotomy posteriorly at the same sitting. Aspiration needle withdrawn; its point of entrance marked on skin with knife. Resection of the greater portion of seventh and eighth ribs with excision of the intercostal soft tissues posteriorly over the adherent lung, and ligation of intercostal arteries near the stump of the ribs. Quite some area of lung is thus exposed. Incision in ninth interspace in scapular line down to pleura with operator's second and third left fingers as guide within the pleural cavity; pleura bluntly perforated with dressing forceps, blades spread and Kenyon's drain, the size of middle finger, with lateral hole near its end, introduced for about $2\frac{1}{2}$ inches. Careful suturing of intercostal muscles of fascia and of skin in layers, tightly around the tube, the former tissues with chromicized gut, the skin with silkworm gut; split piece of gauze slipped under cork and the latter fastened with partially divided strips of 2-inch wide zinc adhesive plaster in such a way that the plaster runs somewhat up on the tube and at the same time holds the cork tightly down to the wound dressing and the surface of the chest. Three such pieces of divided zinc plaster, running in various directions, are put in place over the cork (Fig. 9). They make the drainage tube an absolute unit with the chest wall and that in an air-tight way; outer long end of tube closed with artery clamp. Now intercostal wound sutured in its anterior portion, in part over a short tamponing piece of iodoform gauze, because the pleural incision itself could not be satisfactorily closed by stitches in its entire length; aspirating needle re-introduced at place marked before, now draws principally air into the well-working record syringe, with just a few flakes of pus. Evidently the cavity had been successfully struck again. Alongside the needle the lung is incised with the Paquelin cautery parallel to spine, viz.: in a perpendicular direction. In considerable depth the cavity is opened, clearly representing an irregular distention of a bronchus. The palpating finger, on widening this bronchus toward the lung hilus, enters with its tip into another communicating cavity. Drainage and tamponade with split rubber tubes and iodoform gauze; lung wound left wide open. Patient returned to bed with pleural drainage started; head of bed raised. Air-bubbles and bloody fluid escape at once.

First twenty-four hours: 100 c.c. of serosanguinolent fluid drained off; slight rise of temperature. Twenty hours after operation suddenly very rapid pulse and respiration; patient restless. Secretion: turbid serum.

Second twenty-four hours: Temperature rising; much cough; controlled by morphine; secretion turbid, contains pus and bacteria which prove to be streptococci. Amount not charted. Diagnosis: Acute suppurative pleurisy.

Third twenty-four hours: Discharge more purulent; 200 c.c. drained off into bottle.

Fourth twenty-four hours: Better; fever dropping.



FIG. 8.—The simple make-up of Kenyon's drain adapted to drainage after thoracic operations beyond the pleural cavity. The centre hole in the cork is, of course, somewhat smaller than the circumference of the tube; the latter has to be of good size and of medium elasticity. By putting the tube on the stretch, the cork can be slipped up or down. The latter distends in boiling and then holds the tube less tightly. This point has to be carefully decided before the operation, and matters must be properly adjusted.



FIG. 9.—The drain in place. In practice the patient rests in a slight Fowler's posture with the shoulder of the drained side supported and the head of the bed raised on blocks as long as the drainage lasts.



FIG. 10.



FIG. 11.



FIG. 12.

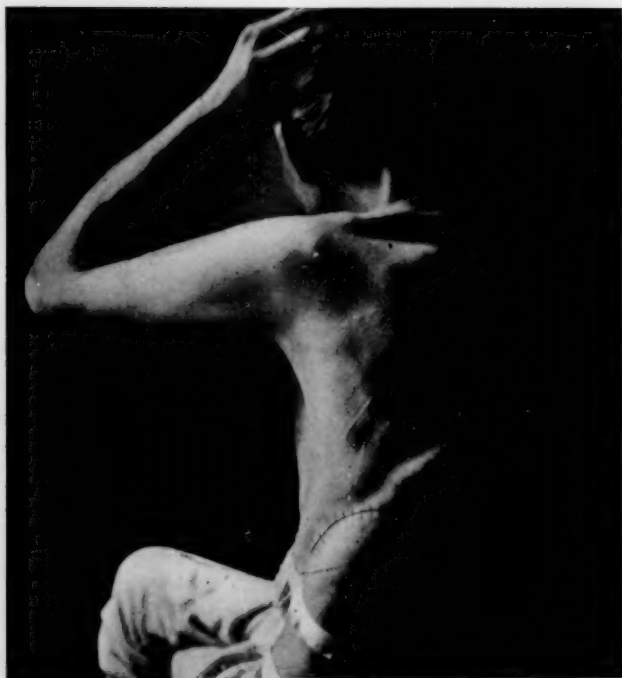


FIG. 13.—Photo taken a few days before patient's death, five months after the exploratory thoracotomy.

POST-OPERATIVE THORACIC DRAINAGE

Fifth twenty-four hours: Further improvement; amount of drainage = 100 c.c.

Sixth day: Drainage = 75 c.c. From now on, slow drying-up. First change of dressing: primary union of chest wound; iodoform gauze tampon removed over pleural incision; the latter has firmly closed. Thoracic drain pulled out for about one inch. It is again secured in place with the adhesive plaster strips.

Seventh day: Small drain inserted to replace large one; out of bed.

Small drain removed on eleventh day after operation; recovery with complete closure of chest wound; no bronchial fistula (Fig. 10).

Comment.—In this case an acute suppurative pleurisy developed under our eyes; threatening at first, it was quickly and successfully overcome by the presence of the large drain in the most dependent spot of the pleural cavity. This proved the great value and necessity of post-operative thoracic drainage, and greatly strengthened our faith in the efficacy of this method of after-treatment.

CASE III.—*Osteosarcoma of ribs; resection of chest-wall; post-operative drainage of chest (Kenyon). Recovery.*

Female, fifty-four years old; tumor immediately below right breast, involving several ribs in mammary line.

Operation (March 5, 1917).—Intratracheal insufflation (Doctors Sanford and Pickhardt). Formation of a large oval skin-flap with convexity downward, from axillary to middle line, with which right breast is raised. Resection of chest wall within healthy tissue; a rectangular piece, including four ribs, is cut out. Kenyon's drain placed in ninth intercostal space, posteriorly; careful stitching of skin-flap in place. With tube held firmly *in situ*, the lung is blown up before the last skin sutures are tied and the outer end of the tube then firmly clamped, in this way driving out as much air as possible. On raising the head of the bed, after the patient had been returned to the ward, and connecting the drainage tube with the bottle, only bloody fluid was seen to escape, no air bubbles, showing that the lung had been fully blown up. The patient breathed comfortably.

Amount of drainage: First twenty-four hours, 400 c.c.; second twenty-four hours 175 c.c.; third twenty-four hours, 50 c.c. From this day on drainage ceased.

On the fourth day, the adhesive plaster around tube and cork was lifted in part and the tube pulled out about 1½ inches and then re-fastened, leaving dressing otherwise undisturbed. First change of dressing on seventh day. Primary union of wound. Large drain exchanged for smaller one; patient out of bed. Drain left out entirely two days later (Fig. 11).

Comment.—It would likely have been perfectly proper to remove the drain on the fourth day after the operation, when drainage from the chest had ceased. It was kept in place three days longer merely for safety's sake. The substitution of the smaller sized drain for the larger one might then be dispensed with.

Of course, I am well aware that many cases of successful resection of

the chest wall, without drainage, are on record. However, the case ran such a normal and undisturbed course and the presence of the drain created so little discomfort, that it might be wise, for the sake of insuring smooth recovery, to resort to post-operative drainage also in these least complicated cases.

CASE IV.—Bronchiectasis of left upper and lower lobe; two-stage operation planned; thoracotomy, firm total adhesion of lung, loosening, tamponade, drainage, closure of thorax; pneumonia on fourth day after operation; exitus on fifth day.

Male, forty years of age. Bronchiectasis of left upper and lower lobe. Pneumonia two and a half years ago, lasting two weeks; cough never ceased; sputum soon foul. Clinical examination, X-rays and bronchoscopy show both left lobes involved.

Operation (April 16, 1917).—Plan: Excision of left lung in two stages (Robinson). Incision in eighth intercostal; four ribs divided posteriorly, parallel to spine; lung found completely and firmly adherent all around; gradually loosened and lifted out with difficulty; pedicle formation of entire lung. Kenyon's drain placed in para-vertebral line in ninth intercostal. Large aseptic gauze tampons packed around lung, separating it from chest wall, pericardium and mediastinum. Wound closed by layer sutures. Patient left operating table in good condition. Head of bed raised. Drainage: First twenty-four hours, 250 c.c. bloody serum; second twenty-four hours, 700 c.c.; third twenty-four hours, 600 c.c.; fourth twenty-four hours, 400 c.c.

In the second half of the fourth day, great difficulty in expectoration; signs of pneumonia appear, to which the patient succumbs on the following day.

Only wound inspection allowed. Lung completely collapsed; pleural cavity contains but a small amount of fluid.

Comment.—In view of the firm adhesions of the lung in its entire circumference to the chest-wall, pericardium and mediastinal landmarks, it might have been wiser in this case to subdivide the operation still further, and attack only the lower lobe at first. Superior lobectomy could then have followed at a later stage of the operation. Proceeding in this way, the pleural cavity might well have been left wide open with drains in place, as a complete post-operative pneumothorax was impossible on account of the firm fixation of the upper lobe. Had this plan of operation been followed patient might have had a better chance to pull through.

The experience had in this case shaped into a definite resolve, what had before been a mere thought, suggested by a previous unfortunate issue, namely, never again to enter the thorax with a fixed plan, but to be guided by local conditions as found during operation, same as we are in our abdominal work. The method of drainage worked admirably also in this instance.

CASE V.—Malignant stricture of œsophagus; gastrostomy; exploratory thoracotomy; case inoperable; Kenyon's drainage; recovery.

POST-OPERATIVE THORACIC DRAINAGE

Male, sixty years old; emaciated; cholelithiasis. Stricture of œsophagus 34 cm. from incisor teeth; proved by X-ray and sound. Œsophagoscopy: Sloughing mass; removed specimen shows squamous-celled epithelioma.

May 10, 1917: Gastrostomy (Witzel). June 14, thoracotomy under intratracheal insufflation, in eighth interspace, curved, periscapular; four ribs divided. Carcinomatous mass in lower end of œsophagus; mediastinal glands involved; multiple lung metastasis; therefore, inoperable. Typical insertion of Kenyon's drain, held in place with zinc adhesive plaster. Again it is observed, on raising the head of the bed, that drainage begins at once and continues. Drainage record: First day, 150 c.c.; second day, 65 c.c.; third day, 20 c.c.; fourth day, 25 c.c.; fifth day, 25 c.c.; sixth day, 20 c.c.

Highest temperature 102° on second day; smooth recovery. Tube removed on seventh day after operation. Primary union of chest incision (Fig. 12).

CASE VI.—*Cancerous stricture of œsophagus; gastrostomy; exploratory thoracotomy; tumor inoperable; Kenyon's drain; recovery.*

Male, fifty-two years of age; constricting tumor 35 cm. behind teeth; specimen removed, shows carcinoma simplex. Preliminary gastrostomy.

June 15, 1917: Thoracotomy in eighth intercostal space; five ribs divided; tumor splendidly adapted for resection as regards location, but forms an inseparable unit with aorta; inoperable; drainage and closure as in foregoing case. After dressings have been applied tube is connected with bottle while patient is still on the operating table in horizontal posture; large amount of air-bubbles pass out of lower end of tube with each respiration, indicating distention of lung. When bubbles cease to appear, tube is clamped. Patient removed to bed and tube there re-connected with bottle, when a few more air-bubbles appear. Again head of bed raised, which is immediately followed by a pronounced bloody secretion flowing through the tube into the bottle, part of the fluid moving to and fro in the drainage arrangement, as can well be observed in the glass tube which interrupts the rubber tubing just before it reaches the bottle. Smooth recovery. Highest temperature 102.4° . Drainage record: on first six days, 400 c.c., 425 c.c., 25 c.c., 10 c.c., 65 c.c., 20 c.c. per day respectively. Tube removed on sixth day after operation (Fig. 13).

This mode of drainage was applied in two further cases. However, they cannot be used in connection with the question here under discussion, viz., air-tight closure of the pleural sac plus drainage, because in neither of them could the chest be closed air-tight.

The number of patients so far treated with this kind of drainage is small and hardly allows of drawing definite conclusions. Still, the impression which the course of the convalescence of the patients made on the observer was, that this method of thoracic drainage, originally devised by Kenyon for the after-treatment of empyema in children, is also very useful for post-operative thoracic drainage in general. It fulfills—be it emphasized once more—the demand of air-tight closure of the thoracic cavity (Sauerbruch),

thus absolutely eliminating the possibility of a post-operative acute pneumothorax, and, at the same time, drains off wound secretions and pleuritic effusions as they will occur after surgical work within the thorax.

It must be remembered that the tendency of the pleura is, to answer to lesions as they occur in the course of an operation with a rapid, usually serosanguinolent effusion, which, besides being more or less septic in character, will compress the lung of the side operated upon, often push the heart to the opposite side and exert a deleterious effect also upon the physiological action of the other lung. This reaction of the pleura is in great contrast to that of the peritoneum which, after an operation, rapidly forms adhesions rather than a copious exudate. To be enabled to drain off by means of a simple, uncomplicated procedure such pleuritic effusion, beginning with it *immediately* after the completion of the operation, besides assisting the proper expansion of the lung by means of the air-tight closure of the wound, involves, therefore, a tremendous advantage for the patient. It also affords the surgeon the great satisfaction that he can institute drainage, when working in the thorax, the same as in other parts of the body, whenever he finds it indicated.

Kenyon's method of thoracic drainage further fits in nicely with our present clinical procedure when draining other, smaller cavities of the body, *e.g.*, the gall-bladder, urinary bladder, kidney, pelvis, etc. We can watch the character of the fluid from hour to hour and from day to day; we can easily read off the quantity for 12 and 24 hours and thus determine when drainage may be dispensed with; the bottle used for siphonage can be easily and safely exchanged. For the latter reasons Kenyon's method of drainage is superior in these cases to Tiegel's drain and similarly to Theodore Dunham's pretty device, which he presented before the N. Y. Surgical Society on January 9, 1918, having tried it successfully in one case of empyema in a child. Working with either one of these devices the wound secretions drain off into the dressing without giving the surgeon the opportunity of regular observation as to their quality and quantity.

For the same reason Kenyon's drain seems preferable in the after-treatment of operations here under discussion to the method of drainage published by Fred. B. Lund, of Boston, and also its modification by A. S. Taylor, of New York, as well as that of J. Ransohoff, of Cincinnati.

Lund (*ANNALS OF SURGERY*, 1914, vol. lx, p. 126) in operating for empyema makes an incision in the skin over the rib below the one he expects to take out, undermines the skin upward, resects the rib above and then sutures the top of the lower lip of the wound in the bed of the resected rib to the lower border of the skin incision (at least, this is the way I understood his remarks made in a discussion). A large hole is thus made for the pus to come out, while a long flap of skin comes down over it, so that the air cannot go in.

Taylor states (*ANNALS OF SURGERY*, 1916, vol. lxiv, p. 730) that Lund puts a rubber tube obliquely underneath the skin; the skin flap falling over the end of the tube, produces automatic closure.

POST-OPERATIVE THORACIC DRAINAGE

Taylor undermines the skin in the same way, resects a portion of the rib above the skin incision, then elevates a flap of rib periosteum plus costal pleura upward from the wound; this flap is made broad and long enough to permit of its being turned downward over the rib below and sutured to the lower margin of the wound, so as to make a drainage channel which will not readily heal together rapidly with the overlying skin. A suture or two may be placed at each angle of the skin wound, so that the valve action may be controlled. Over the outside a ring of cotton or gauze is arranged to surround the entire wound area, so that no direct pressure is exerted upon the skin flap. An absorbent dressing of good size is then applied to catch the discharge. Every second day a pair of smooth scissors is passed through the channel to prevent the formation of any adhesions. This method gives a perfect ball valve action which can be studied on the table when the operation is finished. Pus and air come out with perfect freedom, but nothing can go back into the empyema cavity; the patients are very comfortable; the lung comes down rapidly into its proper position. Taylor's cases (12-15) all healed without fistula and in much less than the average time. (Personal communication and *ANNALS OF SURGERY*, *loc. cit.*).

Ransohoff (*Jour. Am. Med. Ass'n*, April 15, 1916, vol. lxvi, pp. 1196/7), for the same purpose, advises slipping "an ordinary drainage tube into a collapsible soft rubber tube, which must fit accurately about the harder one for a distance of one inch or more. The soft tube is that ordinarily employed for cigarette drainage. When the harder tube is accurately fitted into the wound, any effort at inspiration will cause the soft outer tube to collapse and prevent the ingress of air. On the other hand, the pressure of the lung from within, with the normal respiratory movement, will be sufficient to open the collapsible tube and permit the escape of whatever pus may be within the chest." In the beginning the collapsible tube is connected with a bottle which is changed as often as necessary. Later on the dressings absorb the discharge. Of course, the inner drainage tube must be made to fit air-tight into the wound in the intercostal space.

Although it has been specifically stated above that the question of drainage in empyema is excluded from this discussion, a suggestion concerning it, with special reference to Kenyon's method of drainage, might here find a place.

In view of the simplicity of inserting Kenyon's drain in an intercostal space, under cocaine, it would seem worth while to test the efficacy of the procedure at present in our military cantonments and general hospitals, with the large and varied number of post-pneumonic pleuritic effusions on hand. By making in addition irrigations with Dakin's solution to dissolve the often present voluminous fibrinous coagulations, the treatment of empyema might eventually be greatly simplified and the lung prevented from collapsing. Drainage could then also be started on any day after the appearance of the effusion, according to the surgeon's judgment. The siphon bottle could easily be exchanged for a freshly sterilized flask filled with Dakin's solution.

If this flask were graduated, the surgeon would have quantity, rapidity, force and frequency of the irrigations under his control by simply raising the bottle slowly or quickly, low or high, above the level of the tube entrance, as often as he considers it indicated. By then rolling the patient over on the healthy side, by gently turning him on abdomen and back, by raising the upper as well as the lower end of the bed, the fluid could probably be made to come in contact with all the parts of the pleural sac. It could be made to stay in as long as desired and then be allowed to drain off. Should it be shown that disinfection cannot be properly accomplished by this means,—perhaps because the large, infected serous cavity remains closed, insufflation of oxygen (or other gas) through the tube, at regular intervals, might bring better results. (It has been observed in the treatment of incised bronchiectatic cavities that the free admission of air, particularly the insufflation of pure oxygen into the cavities, changes the living conditions of the bacteria that habitate these cavities, some of which seem to be partial anaërobes. It is, of course, understood that this may be different with empyema, which usually is produced by one of the pyogenic type of bacteria. Still, it may be worth the trial.)

Basing our conclusions as to the length of the drainage period on the experience had in the above reported cases in so far as they terminated in recovery, it would seem that three times 24 hours are sufficient in the average case of intrathoracic operation. By that time the pleura has practically ceased secreting, at least in larger amounts, and I am almost sure that adhesions of sufficient strength and extent have formed between pulmonary and costal pleura to eliminate the danger of an acute pneumothorax. Nevertheless, it will probably be wise in order to be quite safe, to then exchange the large drain for a smaller one, the latter soon to be left out entirely. In the few cases in which we could so far employ this mode of drainage, we decided, entirely arbitrarily, to leave the tube in place for one week, having pulled it out of the cavity for one or two inches as soon as the secretion had materially lessened in quantity. This question as to the exact duration of the drainage period will have to be decided on basis of further practical experience.

The important point is that we have to-day at our disposal a method of post-operative thoracic drainage which is simple, inexpensive, feasible also in the wards, and which, at the same time, answers all requirements from a practical and scientific point of view. It represents a most important factor of safety in the after-treatment of intrathoracic operations.

In view of these facts and in order to further the evolution of thoracic surgery, it would appear advisable—at the present moment at least—to let *every patient* profit of its clinical advantages, that means, to employ the method in *every case* of intrathoracic operation in which the thorax could be closed air-tight.

It is necessary to add that this method of drainage is of importance not only as a post-operative measure, but also in the treatment of cases of so-called internal injury, when an accumulation of air and blood in the

POST-OPERATIVE THORACIC DRAINAGE

chest is threatening the patient's life, *e.g.*, in fracture of the ribs with injury of the lung, etc. The mere air-tight introduction of the drainage tube into the pleural sac may change the picture at once, by allowing the air and blood to escape and restoring normal pressure conditions. Kenyon presented a most interesting case of this type before the N. Y. Surgical Society on October 25, 1916 (ANNALS OF SURG., 1916, vol. lxiv, p. 728). Many a severely wounded individual in desperate straits may perhaps be tided over or prepared for the required major work by this simple means.

CONCLUSIONS

1. Thoracic operations, same as operations in other parts of the body, often demand drainage.

2. With no adhesions present between the two pleural leaves, an acute post-operative pneumothorax is the inevitable consequence if an ordinary drain—rubber, cigarette, gauze—is introduced. The occurrence of a complete pneumothorax after operation greatly enhances the dangers confronting the patient during the after-treatment.

3. It is, therefore, necessary to avoid this complication. This could hitherto be accomplished either by leaving the patient under the influence of differential air-pressure for a greater part of the first 24 hours following the operation, after having closed the thoracic wound and then covered the drain ends outside with a large piece of rubber dam (Willy Meyer), or by making use of Tiegel's thoracic metal drain. Both methods have been tried and found satisfactory; both, however, for the question here under discussion, have certain drawbacks.

4. Kenyon's method of draining empyema in children has been found to be useful also for post-operative thoracic drainage in general. It is simple, safe and easy of execution. It permits of satisfactory observation of the quality and quantity of the effused fluid.

5. Kenyon's method of post-operative drainage fulfils Sauerbruch's demand that the thorax be closed air- and water-tight after intrathoracic operations. Yet, it permits of draining off, in an efficient manner, the secretions of the pleura, which follow the majority of intrathoracic operations, and usually are not sterile.

6. The introduction of Kenyon's method of drainage, therefore, bids fair to mean a long step forward in the evolution of thoracic surgery. It greatly adds to the safety of intrathoracic surgical work, and should, for the present at least, be employed *after every operation* upon the thorax in which the free pleural cavity, particularly a "virgin-pleura," had to be traversed.

Summarizing, we may say, that, at the present moment, the successful issue of our surgical work within the thorax seems best assured by combining immediate, complete closure of the incision with an efficient method of simple and safe drainage of fluid and air,—without allowing the latter to regurgitate into the chest.

THE TREATMENT OF DISEASES OF THE COSTAL CARTILAGES*

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It has been my privilege to see quite a number of patients who suffered from diseased costal cartilages, both in my own service and in that of my colleagues. With the exception of an occasional case of proven actinomycotic infection, practically all of the remaining cases were regarded as tuberculous. All the cases were examined with care, in order to determine a possible infecting organism. Many were reported as positively tuberculous. In others a precise diagnosis of tuberculosis could not be made, owing to an overwhelming secondary infection. Despite the failure to make a pathological diagnosis, we regarded such cases as clinically tuberculous; a view which we deemed fortified because established therapeutic efforts, even to the extent of radical extirpation of the diseased tissues, did not always result in a cure.

On rare occasions I succeeded in permanently curing a patient afflicted with diseased costal cartilages; but the cure was dearly bought, and only at the expense of extensive operations and long invalidism. I also confess that I did not interpret correctly the reason or reasons why I failed to heal many of these cases. If a case was cured I assumed that the supposed tuberculous tissue was completely extirpated. I now know that the real reason was, because the last operation, after many unsuccessful preliminary ones, finally removed the last trace of cartilage, no matter whether diseased or healthy, thereby permitting a final closure of the wound. I feel safe in saying, that my experience mirrors that of many other surgeons. Indeed, it is therefore not at all surprising to read articles written even as late as the latter part of the nineteenth century, in which the writers regard "tuberculosis" of the costal cartilages as *noli me tangere* as far as operative treatment is concerned.

The natural history of a patient with diseased costal cartilages is approximately the following. In the very early stage the patient usually presents himself with a fluctuating swelling either directly over the centre or near the end of a cartilage. It is stated by some observers, notably Koenig,¹ that the abscess is frequently located at some distance from the diseased cartilage, forming a so-called "Senkungs Abscess," but I am not able to verify these observations from personal experience. It may be safely assumed that in a great majority of instances a diagnosis of a chronic or so-called "cold abscess" only is made. In a small number only is the diagnosis made of an abscess, the etiology of which is in the osseous system. Very rarely indeed is the refined differentiation made as to whether bone or cartilage is at the bottom of the trouble. If the location leads to a diagnosis of an abscess

* Read before the American Surgical Association, June 6 to 8, 1918.

DISEASES OF THE COSTAL CARTILAGES

due to a diseased costal cartilage, it is not generally appreciated that the case is something quite out of the ordinary, and, prognostically at least, a disease of long duration. Even surgeons of great experience frequently fall into the error of transferring their diagnostic as well as therapeutic experiences gained from treating bone abscesses to cartilaginous abscesses. In the course of time the abscess begins to point, and is either incised or it perforates spontaneously. The incision of the abscess is very tempting, particularly to those who are not intimately acquainted with the natural history of these cases. It is a ridiculously simple matter to make an incision into the abscess, and to pack the cavity; and the uninitiated is usually full of expectation, that the abscess will heal like any other well-regulated abscess. This, however, does not happen; a sinus remains, which continues to discharge smaller or larger amounts of pus.

The abscess now enters into the second stage, which may be termed the "laboratory stage." Persistence of the sinus gives rise to the suspicion that it may be caused by tuberculosis. Various biological and other tests are now made to confirm this suspicion; in a majority of cases these prove to be positive; even to the finding of the tubercle bacillus.

The abscess next enters into a brief third stage which may be called the "stage of the curette." The old incision is reopened, the fistula and underlying cartilage is curetted, and the wound is dressed with iodoform or other irritating substances. Treatment with Bier cups, hyperthermy, and heliotherapy is not infrequently tried. A persistent physician may repeat this manoeuvre once or twice, but finally the case enters upon the fourth stage, the stage of "unsuccessful surgery."

By the time this stage has been reached there are present usually anywhere from one to a dozen profusely discharging sinuses; curiously enough these sinuses are located, not as one might expect over one particular rib, but usually over a number of adjacent ribs. This is such a curious phenomenon that it alone should have aroused suspicion that something was radically wrong either with the disease, the diagnosis, or the therapeutic efforts, or all three combined. The subsequent course depends really more upon the temperament of the surgeon in charge of the case than upon his scientific acumen.

If the surgeon be of a very enthusiastic temperament, the procedure is usually the following: A liberal incision is made over the offending cartilages. Usually a bare area, either on the anterior or posterior surface, is discovered, and the inference is quite properly drawn, that the subjacent cartilage is necrotic, or at least so diseased that it will eventually become necrotic. This portion of the cartilage is therefore excised subperichondrally, going well into healthy tissues. All of the granulation tissue wherever found is very thoroughly removed by means of a curette. Owing to the fear of a persisting infection of the wound from the preëxisting sinus the wound is lightly packed with either plain or iodoform gauze.

At the first dressing everything looks clean and sweet; in fact, it con-

tinues to do so forever, if only sufficient aseptic precautions are taken not to reinfect the wound. But to the surprise of the surgeon, not to speak of the patient, the wound does not heal definitely, and again a sinus forms. In the course of time another operation of a similar nature and with a similar result is undertaken. If this is only repeated often enough, *i.e.*, until all of the cartilage shall have been removed, the surgeon will find to his immense satisfaction that the wound has permanently healed.

I confess that I have been guilty of the same course of surgical conduct, and it was only after repeated failures that I began to discover the real cause of my mistakes.

I gained my first lesson when I discovered that, contrary to my expectations, my operations were truly radical. I found, namely, that tissue extirpated at a second operation, provided of course that the first operation was properly done, was never reported by the pathologist as tuberculous. This taught me that it was not the tuberculous infection which prevented healing.

The second discovery was this: I found, no matter how radically the offending cartilage was removed, that at the subsequent operation, the ends of the cartilage were found practically unchanged.

The third point of far-reaching importance which came to light was the fact that, at re-operations, not only the cartilage operated upon, but also the adjacent ones were found devoid of perichondrium. I can only explain this peculiar phenomenon by the extreme delicacy and vulnerability of the perichondrium. It is probably this circumstance that has induced Axhausen,² Roepke,³ and Martina⁴ to give the condition the name "Progrediente Knorpelnecrose," *i.e.*, "Progressive necrosis of the cartilages." I do not consider the name happily chosen, in spite of its descriptive nature. It is prone to create the impression, that there is something in the nature of the disease which leads to the progressive involvement of more and more cartilages; whereas strictly speaking each successive cartilage becomes involved only through renewed traumata. If these are only avoided there is also an excellent likelihood that no further cartilages will become involved. A perfect example of such a possibility is the following case:

CASE I.—A. L., seventy-two years of age, who two years ago made a perfect recovery after a prostatectomy performed by Dr. Edwin Beer, developed a cold abscess over the lower part of the left chest in the spring of 1916. After evacuating the abscess, which contained over four ounces of pus (t.b.c. found), cartilage devoid of perichondrium was encountered. Doctor Beer resected the cartilage, going wide of the disease into absolutely healthy tissue. Eventually the incision became a sinus, which was treated with various injections, hyperthermy, Bier cups, etc. The sinus was taken care of excellently, but has remained open ever since that time. I have seen the patient through the courtesy of Doctor Beer and apparently only the originally affected cartilage is involved.

DISEASES OF THE COSTAL CARTILAGES

I am materially strengthened in this observation by the following case reported by Martina (*l. c.*). An abscess following typhoid fever (*B. Coli* found in culture), the size of an orange, developed in the region of the third costal cartilage. At the operation, which was done by Payr, a very ample incision was made and the third and fourth costal cartilages were thoroughly examined. The perichondrium was found to be absolutely intact. Payr, however, made the mistake, almost natural one might say, to pack the wound with iodoform gauze. A chronic fistula formed, which necessitated a second operation, and this disclosed the third costal cartilage devoid of its anterior perichondrium and completely necrotic. There can be no doubt that the chondritis in this case was due to a perichondritis, which in turn was caused by the gauze tamponade.

It was at this period that there began to dawn upon me the notion, that it was not the character of the infecting organisms, but some factor either peculiar to cartilaginous tissue, or to the method of treatment, which is the cause of the non-healing of the wound.

Already some years ago I had noted a similar difficulty in performing exarticulations of an extremity, in which, owing to the infectious nature of the joint, I deemed it proper to drain. I found, namely, that if the joint was drained with a wick of gauze it required an interminable time until healing finally occurred. For a long time the exposed joint cartilage looked and behaved like perfectly normal cartilage; subsequently the cartilage appeared as if it would become necrotic, it became discolored and lost its translucency; finally another interminable time elapsed, until the cartilage really became exfoliated, and then, and then only, did the exarticulation wound finally heal. Fearing this protracted wound healing, I took what at first sight appeared to be an unwarranted risk, and closed up such an exarticulation wound by suture. Much to my gratification these cases healed up by first intention and remained healed.

In the course of time I resolved to cautiously apply the principle involved in these joint exarticulations to the next case of diseased costal cartilages which presented itself. No case, however, presented itself until 1912, and was the following:

CASE II.—C. M., thirty-eight years of age, was admitted for the first time to Mt. Sinai Hospital in the service of Dr. A. G. Gerster, to which I was then attached, September 23, 1912. Twelve years ago the patient had a chancre, which was very probably syphilitic, although no history of any secondary symptoms is obtainable; he had been treated spasmodically with mercury and potassium iodide. One year ago the big toe of the right foot was amputated for a tuberculous osteomyelitis. Ten months ago a tender swelling appeared over the lower part of the chest, to the right of the sternum, which was incised, but had never healed. Patient is admitted to the hospital for the cure of this discharging sinus.

On physical examination, in addition to other points of secondary importance (luetie cicatrices and luetic adenopathy) there was found upon the anterior portion of the right chest a circular ulceration, about one-half inch in diameter, the edges of which were sharp and clean cut;

its base was covered by unhealthy granulations. A probe could be passed for several inches in various directions radiating from the ulcer, which accounted for the extraordinarily profuse discharge.

Patient was operated upon September 28, 1912. An incision several inches in length, parallel to the affected cartilage, was made. Necrotic cartilages devoid of perichondrium and a large mass of necrotic fluffy granulations were exposed. The affected soft tissues were excised and curetted away, and all the cartilages which were diseased were resected subperichondrally in absolutely healthy tissues. The ends of the exposed cartilages were now covered with flaps of healthy muscle or fascia taken from the neighborhood. The skin was sutured completely, as far as possible. In excising the original ulcer so much skin had to be sacrificed that it was impossible to close the entire wound; a small portion of it was therefore packed with gauze. First dressing October 4th. Much to our surprise the entire sutured portion of the wound had healed by primary union. By October 27th the entire wound was healed and patient was discharged cured.

The result was so remarkable as compared to our previous experience that I presented the patient, twenty-five days after the operation, at a meeting of the New York Surgical Society held October 23, 1912. To my chagrin shortly thereafter a sinus formed in the angle of one of the incisions, and after ineffectual attempts at a cure by topical applications, Bier cups, hyperthermy, heliotherapy, etc., the patient had to be readmitted to the hospital November 25, 1912.

The principal reason for his readmission was that a sinus formed at the site of the previous operation for the tuberculous osteomyelitis of the great toe. This was cured only after laying the sinus wide open and curetting the wound.

In reality I was annoyed even more than the patient by the fistula which had formed on the thorax, and I again gained his consent to a further attempt at a cure. He was again operated upon December 19, 1912. A probe introduced into the sinus passed upward and inward. This sinus was laid open, and several branch sinuses were found, leading from the main channel; all of these were thoroughly curetted, and were found to lead at various points to newly formed cartilage (chondrophytes) or to cartilage bared and divided at the original operation. Everything was now cut ruthlessly away; all the exposed cartilages were resected in healthy parts; and the ends again covered with fascial flaps. By January 8th the thoracic wound was granulating very satisfactorily, and patient was discharged into ambulatory treatment.

He was readmitted July 1, 1913. His principal complaints now were those of a dull pain to the right of the hypogastric region and in the right iliac fossa. The thoracic wound had not healed completely.

In spite of the suspicion of a tuberculous deposit in the abdomen, a further attempt was made to cure the thoracic condition. Patient was again operated upon July 5, 1913. The costal cartilages affected were all exposed and removed, well into the ribs and into the sternum; after curetting away all the diseased granulations the wound was packed. Very little reaction followed this extensive procedure, and patient was

DISEASES OF THE COSTAL CARTILAGES

up and about four days later. He was dressed the first time July 16, and the wound was found covered throughout with healthy granulations. July 27 the patient complained of severe headache; he appeared to be drowsy, stuporous and extraordinarily quiet. Physical examination did not reveal anything abnormal; but upon the supposition of a meningeal involvement a lumbar puncture was made, which revealed the presence of tubercle bacilli; pneumonia supervened and patient died August 2, 1913.

In connection with this case it is important to bear in mind the various pathological diagnoses, as reported by Dr. F. S. Mandlebaum.

1. Granulation tissue excised at the first thoracic operation was reported as tuberculous.

2. Granulation tissue excised at all subsequent thoracic operations was reported as non-tuberculous.

3. Granulation tissue excised from sinus of the great toe reported as tuberculous.

4. Spinal puncture fluid was reported as tuberculous.

As already stated I was so pleased with the primary result obtained in this case that I presented the patient October 23, 1912, only twenty-five days after the first operation, at a meeting of the New York Surgical Society. Curiously enough my attention was called at about the same time to an article by Axhausen (*l. c.*), which had just then appeared.

AXHAUSEN relates in detail the history of a patient afflicted with tuberculosis of the sixth rib, in whom the rib did not heal after repeated operations. On the contrary, whereas after the first operation only one sinus existed, which led to the stump of the sixth costal cartilage, after the last operation several sinuses appeared, which led to the fifth and seventh ribs as well. It is also interesting to note that, just as in my case, only the specimens removed at the first operation showed tuberculosis; not the later ones. Axhausen with characteristic thoroughness utilized this case to investigate very carefully the reasons of the non-healing of infected wounds of the cartilages. These investigations enabled him to make a number of very important and valuable observations.

Primarily he lays stress upon the great difference in the blood supply of bone and cartilage. Whereas the former is very porous and has a very rich vascular supply, the latter is much more compact and is extremely poor in blood-vessels. This alone would speak for a much more rapid recuperative energy in the former. It is well known, for instance, how rapidly a bone injury becomes repaired, while an injury of cartilage of similar extent remains practically unchanged for a very long period.

In this connection I also wish to mention, that as far back as 1899 Lampe^{*} studied intensively the vascular supply of the costal cartilages, and found that prior to the fourth decennium they have practically no direct or visible blood supply; only that part of the costal cartilages which is directly continuous with the bone appears to be vascularized in the early decennia.

The absence of Haversian canals and cancellous substance in cartilage, both of which are so important in the process of repair of a bone injury, is a second important reason why injuries of cartilage fail to heal. Judging merely from observations upon bone, in which there is a proliferation of the periosteum at the junction of the living and the necrotic bone, and which progressively separates the two, it may be argued that a similar occurrence takes place in cartilage. Experiments and examinations of

a large number of specimens have, however, shown that, although the perichondrium always produces chondrophytes in profusion, these never grow into the cartilage, and thus are of no value in separating the living from the necrotic cartilage. These chondrophytes never become actually continuous with the original cartilage; there is always present a slit-like space between the two, which is filled with pus and granulation tissue.

In fact, Axhausen after a study of the question found a number of other factors which are lacking in cartilage but are present in bone, all of which tend to retardation of the reparative process in an injured cartilage. Of all the factors concerned the only one to which Axhausen attaches a slight value is the lytic function of the leucocytes upon dead cartilage; but that is recognizedly of so slight assistance that, by the time a piece of necrotic cartilage has been gotten rid of by the leucocytes, the adjoining portion of the cartilage becomes affected and also dies. Axhausen leads his readers to believe that eventually every such wound would heal, but it would be practically an interminable time.

Case II of this series is one of especial interest to me, because it proves to me that even if it was a failure I was at least on the right track. I argued that either I was not radical enough, or that I left infectious material behind. In spite of the negative final result I determined to persevere in the method, and to give it another trial. As so frequently happens no other case presented itself to me for a very long time, and even that one was not ideally suitable, because the infection was not tuberculous, but actinomycotic. I was of the opinion, however, that that would not make much difference as far as therapy is concerned.

CASE III.—J. M., thirty-five years of age, was admitted to Mt. Sinai Hospital May 5, 1916. Seven months ago the patient noticed a swelling in front of the sternum, which was incised at a hospital. A sinus remained for which he was reoperated four months later; at the same time another abscess located beneath the right breast was also incised. Four weeks ago a third swelling appeared, which was also incised a few days ago. Patient lost about fifty-five pounds in weight since the onset of his illness.

On physical examination there were found signs and symptoms indicative of the presence of an effusion in the right pleural cavity. Locally three sinuses were found, all of which discharged large amounts of pus; one was located at the second chondrosternal junction; a second was located in the region of the third chondrocostal junction; and the third approximately on a line with the fifth costal cartilage.

Patient was operated upon May 12, 1916. All the sinus tracts were found to intercommunicate. Liberal incisions laid all the sinuses wide open; some were found to lead in front, and some behind, the costal cartilages; a large area covered with necrotic granulations was encountered, and was curetted clean. The costal cartilages overlying the sinus tracts were then all removed. During this procedure the internal mammary artery was injured. After many unsuccessful attempts to surround it by a ligature, owing to the exceedingly dense deposit of cicatricial tissue, the bleeding was finally controlled by a gauze tampon sutured against the bleeding vessel. Because of the long duration of the

DISEASES OF THE COSTAL CARTILAGES

operation and the poor condition of the patient, it was deemed advisable to defer the final steps of the operation to a subsequent session. The wound was therefore packed with a large Mikulicz tampon.

Second operation, May 23d. The incisions from the former operations were extended laterally. The fourth, fifth and sixth costal cartilages were found to be of a light brownish color, and at several points bare of perichondrium. They were resected in healthy parts, and the ends of the freshly cut cartilage covered by fascial and muscle flaps taken from the vicinity. In the region of the fifth intercostal space a separate extrapleural abscess was encountered, which was incised and drained by means of a tube. The greatest portion of the wound was closed by suture; entire closure was not possible because of previous cicatrization. The subsequent course left considerable to be desired. It is true the original foci in the region of the costal cartilages became covered with healthy granulations, but new and new pus foci appeared in the neighborhood of the wound, and required repeated incisions, June 16th and July 4th, but finally the patient was discharged into ambulatory treatment August 6, 1916.

He was readmitted September 5, 1916. During the interval the entire wound had broken down, and numerous sinuses formed again, which showed retention of pus and which called for further revision. Subsequently the patient's health failed very rapidly. He presented himself from time to time in the "follow-up" department; very slight attempt at healing was discernible. Finally I lost track of him, but I have no doubt that he succumbed to a progressive pulmonary involvement. Incidentally I may mention that many of these patients apparently die from coexisting pulmonary disease, particularly in cases of a tuberculous affection of the costal cartilages.

In other words, again a complete failure. I believe, however, I had a valid justification in this case. Actinomycosis is at best so difficult to cure that perhaps the blame is to be attached altogether or at least to a great extent to that, and not to the particular operative method used for its cure.

In the absence of further cases of diseased costal cartilages, I began to pay more and more attention to wounds and injuries of other varieties of cartilage, no matter where located. I devoted particular attention to infected injuries, or to those which were liable to become so, and I have found, that when a cartilage of a joint was exposed in a wound where it was liable to infection, and more particularly when it was traumatized by contact with gauze, it was very liable to become devitalized almost beyond the possibility of recovery. Furthermore, I have also found that it usually required a very long time before cartilage thus infected became exfoliated. The affected cartilage acts as a foreign body and prevents the final closure of the wound. It is entirely immaterial whether the infecting organism was the tubercle bacillus or one of the common pus-producing germs. In other words, there exists in these cases a condition quite analogous to diseases of the costal cartilages. It was but natural to deduct from these observations that a

was not the tuberculosis of the cartilages which gave us the bad results, but any disease of the cartilages.

I was very anxious to prove this observation clinically, but again for a long time no case of diseased costal cartilages presented itself. A case finally presented itself which is particularly convincing, because I was able to follow it from its inception to its final cure.

CASE IV.—M. M., fifty-five years of age, was referred to me in November, 1915, by Dr. H. Schwartz, to whom I am also indebted for the following history. In May, 1915, the patient passed through a very severe attack of typhoid fever of six or seven weeks' duration. For several weeks prior to seeing me the patient complained of indefinite pains in the lower part of the left thorax. A few days ago he noticed a small lump in this location, which was rather tender.

On physical examination there was found a swelling, the size of an egg, slightly above the middle of the left costal margin. It fluctuated distinctly and was slightly tender. A probable diagnosis of an abscess due to a typhoid chondritis was made; although there was also present the possibility that the abscess was located in the soft tissues only, without any involvement of the cartilage. No consent was obtained for any very extensive operation.

Patient was admitted to Mt. Sinai Hospital, and was operated upon November 16, 1915. An incision parallel with the sixth left costal cartilage was made, and an abscess containing over an ounce of pus was encountered. A sinus was found which led underneath the cartilage towards the median line. The cartilage was bare of perichondrium, of a dark brownish color, and apparently necrotic. All of the necrotic cartilage was excised, and all of the granulation tissue was curetted away. Flaps of fascia and muscle were now brought down and were fixed into the defect between the two ends of the resected cartilages. The skin was sutured in part, and the remainder packed with gauze, in such a manner that the gauze did not touch the cartilage anywhere, but helped very effectively to hold down the aforementioned fascia-muscle flaps. Primary union of the sutured portion of the wound, but patient was discharged with a small granulating wound.

Subsequently the patient was under treatment with heliotherapy, hyperthermy, injection of iodine, iodoform glycerin, and other irritants, but the fistula failed to close. Indeed, another fistula formed; it appeared that each fistula led down to one end of the resected rib. The condition continued for several months, but finally the patient consented to a radical operation.

He was readmitted to Mt. Sinai Hospital and was operated upon April 22, 1916. The old incision was lengthened in both directions, so that it reached approximately from the middle of the sternum to the eighth costochondral junction. The ends of the previously resected cartilage were seen exposed in the wound, appearing just about as they were left on the day of the operation. The entire mass of cartilage

DISEASES OF THE COSTAL CARTILAGES

uniting the sixth, seventh, eighth, ninth, and tenth ribs was excised well into the cancellous tissue of the sternum and the ribs. The entire wound was closed by sutures; only that a small rubber tube drain was inserted into the outer angle of the incision. Primary union resulted, and patient was discharged May 12th, or twenty days after the operation. The drainage sinus was definitely closed one week later. The patient has remained healed ever since that time.

The case just described was most instructive to me. In conjunction with my failures in the past it taught me the one important lesson in the treatment of diseases of costal cartilage, namely, that "radicality" in the operation means the removal of every bit of cartilage; because only in operating in this manner can one be certain that no exposed cartilage is left behind, which may again be the starting point of an intractable sinus. It is true the case required two operations for a final cure, but the first operation was in no sense of the word radical, and was never intended to be taken as such. I fully determined to act in my next case according to the principle just outlined, and intended to operate in a radical manner at the very first operation.

CASE V.—S. D., thirty-two years of age, was admitted upon the medical side of Mt. Sinai Hospital in the service of Doctor Libman, August 11, 1917. He gave a history of an illness of three months' duration and which according to the statement of the patient began shortly after exposure to inclement weather. His principal complaint was that of a sharp sticking pain in the right lower axilla and in the hypochondrium. He has lost about thirty pounds in weight since the onset of his illness. The temperature chart showed a septic curve.

Pus was obtained on aspiration, but in spite of this incontrovertible evidence, he declined operation and left the hospital against advice on September 3, 1917.

He was readmitted September 10. During the interval the condition had become materially worse, particularly as far as the constitutional symptoms were concerned. The physical examination showed that the right lung was restricted in its movements; there was a relative dullness on the right side from the angle of the scapula downward with diminished breath sounds. The blood showed a leucocytosis of 19,000, of which 68 per cent. were polynuclears. Röntgen examination showed no abnormality in the lungs. Fluoroscopy revealed a high position of the diaphragm, with diminished excursion, on the right side. In short, we had a typical picture and physical signs of a subphrenic abscess on the right side.

Patient was transferred to the surgical side and operated upon by my adjunct, Doctor Wilensky, on September 11. After a preliminary aspiration an incision was made over the ninth rib, with the centre of the incision in the posterior axillary line. Three inches of the rib were resected. In excising the rib the pleura was accidentally opened, but was immediately closed by suture. The diaphragm was sewed to the pleura throughout the length of the incision.

September 12th, the second stage of the operation was carried out, and consisted of an incision and evacuation of the subphrenic abscess, which contained over one litre of pus, and communicated with the substance of the liver.

The only noteworthy feature during the after-treatment was that the patient complained of considerable pain in the anterior part of the incision; and that, while the subphrenic abscess healed completely, a shallow sinus remained in the anterior part of the incision. He was discharged October 21st into ambulatory treatment.

As this sinus failed to close definitely, the patient was admitted for the third time November 12, 1917. From the history and anatomical location I made the definite diagnosis that the sinus led down to the cartilage of the ninth rib. In view of my previous experience, I advised Doctor Wilensky to carry out the following radical procedure, which was done November 14th. The sinus existing from the previous operation was probed and curetted; a small piece of loose cartilage was also removed. An incision was now carried just over the free border of the ribs from the sinus to the sternum. The entire mass of cartilage connecting the sixth, seventh, eighth, ninth, and tenth ribs to the sternum was now completely excised, the ribs being divided externally to the costochondral junction, and the cartilage being excised cleanly from the sternum, so that at the termination of the operation not the slightest trace of cartilage was to be seen. A small tube drain was inserted subcutaneously near the old sinus, but the rest of the wound was closed completely. On November 24th the tube was removed; by December 4th the wound was completely closed, and had remained healed ever since.

Epicrisis.—There is absolutely no doubt in my mind, that the only way to explain this case is, that inadvertently there must have occurred an injury of the extreme outer end of the cartilage of the ninth rib, which became infected from the discharges of the subphrenic abscess. When once the cartilage has become infected in this manner, there was no use to waste time by small local operations; I therefore suggested at once the larger but surely radical operation, which led to complete healing in twenty days.

Technic.—The technic of the operation is, so to say, self-evident. Nevertheless, my observations have impressed me with the necessity of emphasizing certain important points.

1. The incision runs parallel with the diseased cartilage, and should be of sufficient size to enable the operator to assure himself beyond any doubt that every bit of cartilage has really been extirpated. When two adjoining cartilages are involved the incision is made preferable in the interosseous space.

2. It is quite evident that radicality in this operation does not mean, as in so many other operations, the extirpation of everything that is diseased, plus a safe margin beyond it. Rather it means the removal of every trace of cartilage that has at any time either before or during the operation become uncovered of its perichondrium. To be absolutely certain, therefore, it fol-

DISEASES OF THE COSTAL CARTILAGES

lows that it is necessary to extirpate the cartilage, and to carry this extirpation well into cancellous tissue, both at the sternal and at the costal extremity. This has a most important bearing upon the technic of the operation, namely, not to injure carelessly an adjoining healthy costal cartilage by either sharp instruments or by crude handling. Should such an accident inadvertently happen I would be guided in dealing with the injury by two factors: first, by the amount of infection present; second, by the fact as to whether or not there is any indication for drainage. If no infection is present, or at least none of a severe nature, one might take the chance to close up the wound entirely; under no circumstances should an injured perichondrium which exposes the cartilage be drained or protected by gauze, as such a contingency is sure to be followed by necrosis of the cartilage and sinus formation.

In this connection I wish to mention an occasional and somewhat peculiar experience I had a number of years ago. It followed amputations of the breast for carcinoma, whenever the assistant failed to properly support the breast, or even pulled upon it, at that stage of the operation when it was being cut away from the underlying costal cartilages. In a few cases it happened that a bit of perichondrium was torn away from a cartilage. If absolute primary union did not take place, this seemingly trivial accident was followed by an interminable sinus. I went so far as to ascribe this sinus formation to a carcinomatous invasion of the cartilage, but this was never verified on histological examination. Since that time I am always very careful to instruct my assistant not to permit any dragging of the breast. When I look back upon that experience I am convinced that the accident was due solely to the trauma and subsequent infection of the costal cartilage.

3. When cartilage has been exposed for a long time in a wound, and more particularly when cartilage has been operated upon subperichondrally, cartilaginous tissue is deposited by the perichondrium in larger or smaller amounts, and forms so-called chondrophytes. The process is quite analogous to the osteal deposit when the periosteum is irritated. In operating upon bone, as a rule, little attention is paid to this newly deposited bone; occasionally pains are even taken to conserve it. When, however, extirpating a diseased cartilage, the total extirpation of the newly-formed chondrophytes is most important; failure to do so may mar an otherwise perfect operation, and will surely be followed by a relapse.

4. It is a comparatively simple matter to extirpate the cartilage of the first, second, third, fourth, or fifth rib, and yet do justice to the postulate, to extirpate the cartilage in its entirety, without leaving even the slightest trace behind. This is, however, a matter of some difficulty, when dealing with a cartilage belonging to one of the next five ribs, namely the sixth, seventh, eighth, ninth, or tenth ribs. The difficulty is due to the fact that the cartilages of all these ribs are joined to each other by cartilaginous tissue. It is quite evident, therefore, that in order not to leave behind any cartilage uncovered by perichondrium, it would be impossible to resect only one

cartilage of these ribs. It follows, therefore, that when any one of the cartilages of these ribs is affected and requires extirpation, it is absolutely necessary to resect not only the affected cartilage, but also the entire mass of cartilage which joins these ribs to each other and to the sternum. This makes the operation one of magnitude, but is, as far as I can see, the only one which is sure to be followed by success.

5. Spontaneous as opposed to artificial disease of the costal cartilages is a malady of advanced life, and is but rarely seen in children or early adult life. I am particular to mention this point, because it is most fortunate for the individual thus afflicted, that in later years the upper part of the ensiform cartilage, with which the cartilage of the seventh rib is occasionally connected, is ossified. Were this not the case, then it may well be imagined that even complete extirpation of the entire mass of cartilage, connecting the sixth, seventh, eighth, ninth, and tenth ribs, need not of necessity lead to a cure; a sinus may form at the xiphoid cartilage, which eventually would lead to the cartilages of the opposite side. As a matter of fact I found several such cases reported in medical literature.

ROEPKE (*l. c.*) reports two such cases. The first patient was thirty-eight years of age, who was cholecystectomized June 10, 1905. The wound was drained by tube and gauze, and healed without any evident disturbances. However, a sinus formed at the upper angle of the incision which led down to a costal cartilage. As the sinus showed no sign of healing, the patient was reoperated October 3, 1905, and the necrotic cartilage excised in healthy tissue. Subsequently on account of persistent sinus formation repeated operations were undertaken, at shorter or longer intervals, necessitating successively the resection of more and more cartilages, until finally practically all of the lower cartilages of both sides had to be extirpated.

Roepke's second case occurred in a man of thirty, and in the more important details is identical with his first case.

A third case similar to Roepke's first case is reported by Müller;* even the etiology (operation for cholecystitis) is identical.

In spite of the removal of such an amount of thoracic protection the operation is not followed by the slightest interference with the movements of the thorax, or with the absolute comfort of the patient. In the course of time new cartilaginous tissue becomes deposited from the perichondrium left behind, which may even become ossified. An X-ray plate of Case IV of this series shows a large amount of bony deposit where the cartilages were extirpated. On the day that the X-ray plates were taken, about one and a half years after the operation, I found the thorax to be perfectly normal in every respect, and there was a deposit of cartilage or bone that was apparent on the X-ray plate.

6. Just a word regarding the incision which is to be used in these major cases. Originally it was an incision in the course of the sinus, to which one or more supplementary incisions were added in various directions. In the case operated upon on my service by Doctor Wilensky, I suggested an incision which extended parallel with the free border of the ribs and extended from midsternum to well beyond the costochondral junction of the eighth rib.

DISEASES OF THE COSTAL CARTILAGES

By properly retracting the incision, an excellent exposure is obtained of all the costal cartilages which have to be resected. The wound is fairly superficial throughout its entire extent, except at its outer angle. I claim no particular originality for the incision; it was so to say self-indicated. I was therefore somewhat surprised when I found in the literature particular incisions described for this operation, which to my mind are needlessly extensive. I refer to the incisions described by Mercade⁷ and by Murphy,⁸ both of which incisions expose so much of the abdominal wall, as to be entirely without reason.

7. In discussing the technic of the operation I wish to particularly discuss in brief the accident which happened to me in Case III, namely the injury of the internal mammary artery. I have not seen this accident mentioned in any one of the reported cases, and yet it is somewhat surprising that this accident does not occur more frequently. I have made the interesting observation that, particularly in cases of tuberculosis of long standing, there are to be seen a number of sinuses which enter the thoracic cavity proper, in one or more interosseous spaces. These sinuses do not occur anywhere in a haphazard fashion; they have a very definite location, namely, about $\frac{1}{2}$ inch from the margin of the sternum; and judging from this anatomical fact alone, I have gained the impression, that the infection has spread inwards along the perforating branches of the internal mammary artery. It is in following up these tracts to their ultimate terminations, that an injury of the internal mammary artery may occur. As a rule, it can be readily controlled by passing a hæmostatic ligature around the vessel. Owing to the deposit of massive fibrous tissue in my case it was impossible to do so. The sinuses just mentioned, as accompanying the perforating branches of the internal mammary artery, have been the cause of a misjudged pathological picture for many years; and many surgeons argued that these fistulous tracts were due to infections which originated within the thorax, such as tuberculous glands, which broke through and made their appearance externally. I believe this is an erroneous observation, and I base my argument upon two reasons: first, because of the constant anatomical locations of the sinus; and second, because in the cases in which I was radical enough to follow up these sinuses into the thoracic cavity, I have been able to find only a shallow abscess cavity, usually overlying the pericardium, and never even a trace of a gland. A third argument is, that in spite of assertions to the contrary no one as far as I know has ever seen such a sinus formation without any disease of the bone or cartilage.

8. No one as yet has been able to follow a perforation of an abscess due to a tuberculous or other infectious process of a cartilage into the underlying pleura or pericardium. Coincident with the infection, there appears to go hand in hand with it, a thickening of these structures and of the fascia endothoracica. It follows therefore that injuries to the pleura and pericardium can and should be avoided by exercising care in separating the posterior perichondrium.

ALEXIS V. MOSCHCOWITZ

9. Finally, I wish to sound a warning, that some of these patients do not stand operations well, and I have seen a number, in which the operation had to be terminated rather abruptly, because the patient went into a condition of shock, even when there is no untoward accident, such as perforation of the pleura or pericardium or unlooked-for hemorrhage. I presume this tendency to shock can be best accounted for by the long duration of the illness previous to operation.

CONCLUSIONS

1. Diseases of the costal cartilages may be caused by any one of the pus-producing germs.

2. The infection is caused most frequently by the tubercle bacillus; next in frequency appears to be the typhoid bacillus.

3. Cartilage exposed in an infected wound does not heal, and practically always forms a sinus.

4. Given the same conditions, *i.e.*, exposed cartilage, plus infection, a relapse is almost certain to occur, even if a portion of the diseased cartilage has been excised, apparently well beyond the infected area.

5. If the conditions are favorable, *i.e.*, in the absence of none, or only very slight infection, the operating surgeon may take the risk and close the wound entirely; under no circumstances should a wound of this nature be drained, and least of all with gauze.

6. The most certain procedure is to remove the offending cartilages throughout their entire extent, so that not even a trace of exposed cartilage is visible in the wound. If any portion of the sixth, seventh, eighth, ninth or tenth costal cartilages are diseased, it is necessary to remove all these cartilages *in toto*, in order to bring about healing.

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THE SURGICAL TREATMENT OF THE CIRRHOSES OF THE LIVER AND THEIR COMPLICATIONS*

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REACTION of the liver to chronic irritation of any kind is in the nature of a connective-tissue disease. The condition was first described by Laënnec, and called cirrhosis by him because of the tawny, yellowish color of the atrophic form. The meaning this term carries to our minds is that of a sclerosis, which perhaps more nearly represents the actual condition. This connective-tissue deposit may be local or general and its morphology varies like the patterns of a carpet. A tendency has been exhibited to make minute and complicated classifications based on pattern designs. But if we bear in mind that the liver cells are all alike, sharing equally in function, and that the natural reaction of the liver to chronic irritants, without regard to kind, is the development of connective tissue, as about cancer, tuberculosis, syphilis, etc., the basic fact will be established without being lost in a mass of morphologic detail. On the contrary, the response of the liver to acute destructive irritants, whether bacterial, toxic or chemical, is in the nature of an acute fatty degeneration.

In studying the causes of cirrhosis, perverted functions of the liver will be found. Briefly, it may be stated that the functions of the liver are largely the metabolic completion of processes started in the gastro-intestinal digestion of foods: (1) Carbohydrates with the development of saccharids, the body coal, which are used for heating and energizing the body. The ash is eliminated as carbon dioxide by lung ventilation. (2) Amino-acids, of which 18 have been identified resulting from protein digestion, used in tissue building as well as in the development of heat and energy. Urea is one of the end products. (3) Metabolism of fats. The liver acts as a clearing house for these three kinds of food products, converting one into the other, maintaining an equilibrium, and supplying the demands of the tissues by way of the blood stream. The thyroid secretion, as shown by Plummer and Kendall, is the hormone which is most concerned in liberating the contained energy. (4) The liver excretes bile, a valuable adjunct to the intestinal secretions, which contains pigments derived from the blood and various lipoids, of which cholesterin is the best known. (5) The defense function in which protozoa, bacteria, toxins, and chemical poisons are destroyed and eliminated. The gastro-intestinal tract is most important in the first three functions; the spleen participates in the last two. Therefore, the pathology of the liver cannot be studied without cognizance being taken of the splenic filter, which is so closely related to the liver in its physiology and pathology.

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TYPES OF CIRRHOSIS

It is evident that the chronic irritants resulting in the deposit of connective tissue in the liver, and which we recognize as cirrhosis, must arrive through the portal or systemic circulation or through the biliary channels. The cirrhoses then naturally divide themselves into two groups: (1) Portal cirrhosis, in which the irritants, bacterial, toxic and biochemical substances, are received from the intestinal tract and from the spleen by the way of the portal vein, and in which the connective tissue is deposited about the radicles of the portal vein. (2) Biliary cirrhosis, in which the infectious agents reach the biliary ducts by extension of infections from the gall-bladder and great bile-ducts, or from hæmatogenous infections commonly portal or, not rarely, systemic, such as those following pneumonia, typhoid, focal lesions, etc., and in which the connective-tissue deposit is related to the biliary ducts. The many varieties of cirrhosis described are to be looked on as variations and combinations of these two main divisions.

Portal cirrhosis when advanced gives rise to clinical symptoms which depend on portal circulatory obstructions shown by ascites and gastric hemorrhages. Jaundice is absent or a terminal condition. Local areas of portal cirrhosis are not infrequent and often without symptoms.

Biliary cirrhosis, on the contrary, depends on infections in the biliary ducts, and if the whole or the greater part of the liver is involved jaundice is an early, prominent and continuous feature. Ascites is absent or a terminal manifestation. It would appear that we ordinarily recognize as biliary cirrhosis only the late stages of a relatively frequent liver condition after more or less permanent and extensive damage to the liver tissue has taken place. Infections of the gall-bladder and biliary tract are often accompanied by localized cirrhotic processes without definite symptoms.

The spleen will be found to be enlarged in a high percentage of both portal and biliary cirrhoses, and it seems altogether probable that in a certain number of cases this enlargement is primary and causative. However, in many cases the enlarged spleen may be a secondary manifestation of disturbed portal circulation, and the consequent inability of the spleen to rid itself of the toxic products strained from the blood is the cause of the splenomegalia. Certainly it is often difficult to determine whether a given case is one of primary portal cirrhosis with secondary enlargement of the spleen or of primary splenic enlargement with a secondary cirrhosis. Perhaps the nomenclature depends, to a certain extent, on which condition the diagnostician discovers first, that of the liver or the enlarged spleen.

The classical description of the portal cirrhosis of Laënnec, that is, the hob-nail or gin liver, has given rise to a widespread belief that in portal cirrhosis, at least, the liver is small. This is true only of the Laënnec type. It will be found that as many cirrhotic livers are enlarged as are atrophic.

CIRRHOSES OF THE LIVER

We cannot accept the view which is sometimes held that greatly enlarged livers, often containing quantities of fat, later become atrophic. Atrophic cirrhosis is evidently a response more characteristic of the drinking of gin and other spirits, or of pepper excess as seen in India, also of those poisons carried to the liver from the spleen, as seen in the splenic anæmias. The beer drinker is more liable to have a so-called hypertrophic portal cirrhosis, much of the size being due to deposits of fat in the liver. A large proportion of the portal cirrhotics that we have seen were non-alcoholic in origin. Two causes of ascites are frequently mistaken for the portal cirrhosis.

The ascites which attends chronic proliferative polyserositis (Concato's disease) is often confused with the ascitic stage of portal cirrhosis. On opening the polyserositic abdomen in the typical advanced case the peritoneum is found thick and white, and there is great shortening of the intestinal mesentery. The otherwise normal liver and spleen are encased in fibrous coverings. Fluid will usually be found in both pleural cavities, and Pick's syndrome, the result of coincident pericardial effusion or adhesions, is often present. In Guy's Hospital, Fagge found ascites once as the result of Concato's disease to three times as the result of cirrhosis of the liver. Thrombosis of the portal vein and its tributaries, as shown by Warthin, is also a not infrequent cause of chronic ascites and splenomegalia.

Until recently, biliary cirrhosis has been confused with hæmolytic icterus, in which disease the enlarged spleen, for some unknown reason, destroys an excess of red cells, causing hæmatogenous jaundice. The liver becomes enlarged, partly as a result of hyperplasia of the cells, a work compensation, although there is sufficient cell-irritation to cause the deposit of a certain amount of connective tissue. The confusion between hæmolytic icterus and biliary cirrhosis is still further increased by the fact that the bile in the former condition becomes viscid and there is a tendency to the development of gall-stones with the usual secondary biliary infections. More than 60 per cent. of our patients with hæmolytic icterus have had complicating gall-stone disease and a number of these have been under eighteen years of age. Many of our patients with hæmolytic icterus have had gall-stones removed with, of course, failure to relieve the icterus, the relation of the enlarged spleen to the symptoms being unsuspected. The so-called "crises" are often dependent on acute exacerbations of associated gall-stone infections, and we have seen a number of patients with primary hæmolytic icterus and secondary biliary cirrhosis in whom this association was noted. Chronic pancreatitis is often associated with these two conditions, dependent on the biliary infection. In such cases the spleen must be removed to cure the hæmolytic icterus and the gall-stone disease must be relieved by operation, before the patient can be cured. In passing, I might say that in my opinion Hanot's cirrhosis has no pathologic or clinical basis. To a large extent, the disease so designated has been either hæmolytic icterus or biliary cirrhosis, or a combination of the two conditions.

EFFECT OF THE REMOVAL OF THE SPLEEN

It seems probable that when there is great enlargement of the spleen with the cirrheses, the removal of the spleen may, by cutting off the source of much blood, so reduce the portal circulation as to bring it to a point where the cirrhotic liver can carry on its function, or the measure of improvement may come about by preventing those irritants, ordinarily filtered out in the spleen, from reaching the liver. Probably both are factors as in splenic anaemia.

In our series of 52 splenectomies for splenic anaemia there were a considerable number in which the liver showed portal cirrhosis. In five advanced cases of this type the ascites completely disappeared after splenectomy, and the patients have gained so greatly in strength as to be said to be cured, and have been able to work for a number of years. When we consider that the splenic vein under normal conditions is about one-sixth the diameter of the portal vein, and that in the enlarged spleen the vessels are correspondingly increased in size, it will readily be seen that the removal of the spleen in suitable cases affords a quick and certain method of relieving the portal circulation.

I have removed the greatly enlarged spleen in 6 cases of portal cirrhosis; two of the alcoholic type. One patient died too soon after the operation to show benefit, but the other 5 were very greatly relieved. As the operation of splenectomy, which prevents the blood from reaching the portal vein, is not one of great difficulty, it would seem to be even superior, in suitable cases, to the Talma-Drummond-Morrison method of diverting the blood from the portal to the systemic circulation through the venous compensatory channels of Sappey.

The relief of the portal circulation by reducing the amount of blood which enters the liver may also be readily accomplished by the ligation of the inferior mesenteric or superior rectal vessels. A small incision is made through the peritoneal covering of the right side of the sigmoid mesentery and the vessels are doubly ligated and divided, with re-suturing of the peritoneal incision. Considerable experience in such ligations, made in connection with permanent colostomy as the first step of a two-stage removal of the rectum for cancer, has shown that an immense collateral circulation is established through the middle and external hemorrhoidal vessels, and that the bleeding at the second stage, done two weeks later, is so greatly increased as to become troublesome. The coronary arteries of the stomach could be ligated safely, but in the cirrheses this procedure might increase the ever-present danger of gastric hemorrhage.

We have done the Talma-Drummond-Morrison operation twenty-eight times with four operative deaths. Eight of the patients have died at various dates following operation; the remainder have been more or less benefited; five report their condition as good. Various technics have been employed. In a few cases subcutaneous silk drains were placed with one end entering

CIRRHOSES OF THE LIVER

the peritoneal cavity. In two the internal saphenous vein was employed in a similar manner. All in all, we have found that the easiest and safest method is to draw the omentum up through the peritoneum into the incised rectus muscle, suturing it in that position, and closing the fascia carefully over it. On several occasions we have gone down a second time in the vicinity of the previous operation, with a view of increasing the omental attachments, and have found such extensive compensatory circulation, almost entirely venous, that we were obliged to desist, and even with difficulty controlled the hemorrhage. The Eck fistula, which diverts directly from the portal circulation to the vena cava, while occasionally successful experimentally, has as yet no practical value.

Biliary cirrhosis dependent on infections from gall-stones will usually be found complicated by chronic pancreatitis and enlargement of the spleen. The remedy which suggests itself is removal of the gall-stones and drainage of the biliary ducts. The operation should be done as early as possible before extensive secondary duct infections occur, leading to deposits of calculi in the various liver ducts, such as are occasionally found in the terminal stages of the disease. The type of biliary cirrhosis which depends on chronic infection, resulting in a reduction in the lumen of all the ducts of the liver, presents a difficult problem. In several instances, when it seemed indicated, prolonged drainage of the gall-bladder was instituted. This apparently has been of benefit to the patient and suggests that the source of bacterial infection was in the gall-bladder. We have, in selected cases of this kind, made a cholecystogastrostomy or a cholecystoduodenostomy, as they are equally as efficient and less troublesome to the patient than the cholecystostomy. Some of the patients have been greatly benefited; but as a considerable percentage have had coincident chronic pancreatitis which may have interfered with common duct drainage, some part of the improvement may have been derived from relief of this interference.

I have removed a large spleen in five instances in which there was associated advanced biliary cirrhosis, and the results have been extraordinarily good, although none of the patients can be said to be cured. Whether the splenectomy, by reducing the amount of work, acted as a relief to the disturbed liver-function, or whether it was the means whereby bacteria, reaching the blood stream from focal infections in the body, were diverted from the liver, I am unable to determine.

In conclusion I would call attention to splenectomy and similar procedures as a ready means of reducing the portal circulation for the purpose of relieving the subnormal liver of its overload.

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CHOLECYSTITIS *

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AND

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WHILE studying cholecystitis we are endeavoring to retain an open mind on a subject of such magnitude and on which so many conflicting opinions are held as a result of the wide range of symptoms and sequelæ which may accompany or follow gall-bladder disease. The material on which this preliminary report is based will be published more in detail at a later date. It consists of an analysis of 210 cases of gall-bladder disease which we have compiled with laboratory reports, together with animal experiments.

We believe gall-bladder disease is an inflammatory process resulting from bacterial invasion. In culturing our specimens removed at operation we have obtained many strains of streptococci, not only from the lumen but also from the wall of the gall-bladder. We have also found staphylococcus aureus in pure culture from the contents and in the glands along the common duct. We have also on more than a few occasions found an acute appendicitis associated with an acute cholecystitis where, as nearly as one can determine, the same strain of streptococci were recovered from the walls of the appendix and from the gall-bladder as well as from its lumen. We mention the streptococci because they are not a normal inhabitant of the gastro-intestinal tract to the same extent as is the colon bacilli; the latter, of course, being the organism found in the greater number of cases, both in gall-bladder and appendix disease. With these facts one must look farther than in the immediate neighborhood for the source of infection.

Let us for a moment briefly consider the various theories put forward as regards the ways of infection.

1. *Adami's*¹ theory of subinfection through the portal circulation by means of bacteria which gain access to the blood stream. The vast majority of the organisms no doubt are dealt with effectively in the liver, but some may retain their vitality and reach the gall-bladder and thus set up an inflammatory process.

2. *Ascending Biliary Infection*.—That there are reverse peristaltic currents in the bile ducts there is no doubt, for carmine injected into the rectum will appear in the gall-bladder in a few hours. What part, if any, this plays in the production of the primary inflammation we are not at present prepared to say. However, we have an important clinical observation which may have some bearing on this point. A patient, six months previous to admission,

* Read before the American Surgical Association, June 7, 1918.

CHOLECYSTITIS

had an ischio-rectal abscess for which he refused surgical treatment and it ruptured through the skin. Three months later he developed an acute appendicitis, but as he had, since the beginning of his ischio-rectal abscess, an increasingly irregular pulse, his physician thought it wiser to treat it expectantly. On admission he was in a state of marked mental depression and suffering from attacks of biliary colic; he was very markedly jaundiced, with his ischio-rectal abscess still draining. We thought his condition was due to gall-bladder infection and advised operation. His right iliac fossa was a mass of adhesions, with a small stump of his appendix in communication with the cæcum. The pus was removed and the opening closed. The gall-bladder was thick walled and very dark colored. Cholecystectomy was performed and during his convalescence no bile leaked from the stump of the cystic duct. In about five days his jaundice had completely cleared away. This is the fact which interests us most because it must have been caused by an inflammatory process in the common duct below the end of the cystic duct. In other words, despite the intense jaundice, he apparently had an acute cholecystitis and the removal of the septic focus allowed it to clear up. One would think that if ascending infection were a real factor he would have intense jaundice persistently until the common duct was drained.

3. *The Hæmatogeneous Origin*.—Rosenow,² in a paper published, has so admirably shown that this occurs that we can no longer doubt that it may explain the presence of various infections following remote febrile disturbances. Recently we had in our wards a patient who, one week previous to admission, had a severe tonsillitis, and when examined in the hospital had an acute abdomen with a temperature of 103° F. Operation revealed both an appendix and gall-bladder acutely inflamed, covered with fibrin, and from which streptococci were cultured. Such cases are not unique in our experience.

4. *The contiguity infections*—namely, where the gall-bladder is involved merely as an incident to some neighboring condition such as a perforating gastric or duodenal ulcer. This type of infection does not particularly concern us here, however.

The first and third mentioned methods are the ones which appeal to us as the most likely, and also, as suggested by Detweiler,³ they may be associated. We have also found a larger percentage of streptococci in our acute cases than we have in the chronic. In fact, it is rare to find anything but colon in a chronic gall-bladder condition; often in those exhibiting the greatest gross pathology and containing stones, the cultures have been sterile. Is it not possible that the acute infective process is hæmatogenous in origin, and that later a subinfection through the portal circulation with colon bacilli occurs? These can grow more readily in a diseased gall-bladder and overcome the original infection, and then, as they have been rendered less virulent by their passage through the liver, and as the gall-bladder recovers its powers of resistance to their presence in cholecystitis, adhesions, or a deformed gall-bladder with or without stones, result. If such is true, then most gall-

bladder diseases are dealt with a long period of time after their original inflammation. In this disease at present we are differing from our surgical idea of appendicitis. The patients are not urged to have operations when the gall-bladder conditions are first suspected, as they are in appendicitis, for the reason that the immediate danger to the patient is less in the latter disease.

Such logic must lead us then to subdivide the life history of gall-bladder disease into various stages. These reach from the original infection to the time when the patient is driven to an operation for acute empyema or common duct obstruction, or malignancy, or some other such acute disaster. The following is suggested by Babcock ⁴:

First Stage.—It is in this stage of gall-bladder disease that we feel we have the greatest scope for improving our end-results, which in the not far distant past left a great deal to be desired from a surgical standpoint. Most of the patients in this category are obsessed with the idea that they have stomach trouble and form a population from which the various quack remedies for such a condition prove such a lucrative source of revenue.

We feel certain that any surgeon of wide experience will agree with us in believing that the stomach is the source of pathological lesions in less than 10 per cent. of the instances in which the patient and often the medical adviser believe it to be at fault. Not that we believe the gall-bladder to be the sole reflex cause of gastric disturbance, but we feel very strongly that the reflex factor in such is not given the consideration due it in the vast majority of cases. Let us once and for all abolish from our nomenclature "acute indigestion," for who among us can accurately define that diagnosis, and communicate its underlying gastric pathology? Then we have also records of cases confined to bed on special diets for months with no improvement, cleared up when the gall-bladder has been dealt with. Again we have many instances of a disturbance in bowel movements, from obstinate constipation to mucous colitis. We have recently had six cases of the latter who have undergone all the usual non-operative therapeutic measures to combat it, with no relief. These cases have all been markedly benefited by dealing with the gall-bladder pathology and we feel will entirely recover as soon as the large bowel is able to repair the results of the chronic inflammation. The reason for such divergent symptoms being caused by one organ we feel must be due to the difference in the infective organism. It is in this stage, too, where there is nothing to attract one's attention to the gall-bladder that we have evidence of metastatic disease, on the information derived from a questionnaire we are sending to our patients. It is very illuminating to find the number that are relieved of headaches, rheumatism, vomiting, etc., as a result of having their infective focus dealt with. Hence at this time one has to make the diagnosis by a process of elimination rather than by symptoms directly referable to the gall-bladder itself.

Second Stage.—In this stage we have symptoms directly referable to the gall-bladder region, the result of recurrent acute inflammations or the move-

CHOLECYSTITIS

ment of calculi. At this time one has attacks of the typical colic usually attributed to stones, but which, however, may occur in the absence of stone. One can occasionally differentiate these colics clinically previous to operation. That due to stone comes on suddenly, is extremely severe, and ends as suddenly as it came. The colicky attacks, the results of inflammation, come on more gradually and reach their intensity more slowly and are not of such violence as the stone colic and do not leave suddenly, but persist in a dull soreness for some time.

Third Stage.—In this stage, unfortunately, in the past most patients have been subjected to surgical procedure, much to the discredit of the efficacy of gall-bladder surgery. Here we have our dangerous complications, such as acute empyema, perforating gangrene, common duct obstruction, pancreatitis, and let us not forget malignant disease. As aids in diagnosis our laboratory methods have failed us to a very great extent. We can obtain in stomach analysis all gradations from alkalinity to hyperacidity. The X-ray plates in suspected cases of gall-stones at present have not proven of any great service so far as we have been personally concerned. We have had no direct experience with estimation of the cholesterol content in the blood as an indication of stone, but in other hands it has not been of much help and if our contention is correct—that it is an infective and not a metabolic disease—why should it be an aid?

Recently Doctor Rolph⁵ contributed a paper on urobilinuria in relation to gall-bladder disease. At present we cannot make a definite statement in regard to this, but can say that rarely when it has been present have we found a normal gall-bladder, but in its absence we have very often found gall-bladder pathology. In other words, a positive urobilin test in the great majority of instances indicates gall-bladder disease, but a negative test by no means rules it out.

The treatment is essentially surgical. The profession has long since given up the idea of dissolving the stones with drugs, and if it is an infective condition, as we believe it is, then it must be dealt with locally.—Just a word regarding the efficiency of vaccine therapy.—A series of experiments were carried out by the United States Medical Corps in order to determine the efficiency of vaccine in typhoid carriers and this was carried farther on animals, with the conclusion that vaccine therapy had no definite result in improving the condition. Hence, when they are able to definitely deal with the specific organism with no improvement, there is little hope in gall-bladder disease where there is a multiplicity of infecting bacteria.

In the past gall-bladder conditions have really been treated from ten to twenty years too late, all medications previous to that being only for reflex symptoms; hence it behooves us in the future to recognize and deal with the condition during the first stages which may last for from ten to twenty years.

In suggesting such a procedure we are again confronted with a new difficulty, namely, the ability to recognize a pathological gall-bladder in the

gross at the time of operation. For here, you see, you have no stones, and unless there is a severe pericholecystitis there are no adhesions. Many of us in the past have felt chagrined when we operated for gall-stones and found none, with maybe no adhesions, and failed to recognize any pathology about the patient, and then he will turn up years later for some acute surgical emergency in his gall-bladder. It may be interesting to you to have stated the grounds on which we base a diagnosis of pathology in the gross. In the first place, stones are merely an incident in the disease. If there are pericholecystic adhesions there must have been an infection involving not only the wall of the gall-bladder itself, but the surrounding structures, and it is hence obviously pathological. Then again, we have the deformed gall-bladder resulting from a localized fibrosis. These are the easiest. Others may appear and feel normal, but on palpating along the ducts one finds enlarged glands. These we take as an evidence of gall-bladder infection in the absence of any duodenal pathology, and from the glands of such cases we have secured positive cultures.

Again, alteration in the color and thickness we have learned is the result of an inflammatory process which causes fibrin in the muscular wall and alters the circulation to such an extent as to markedly change the color from the normal pearly grey. These cases are all checked up by microscopic examination, and we have yet to remove a gall-bladder which did not show pathological lesions microscopically.

There is much discussion as to whether to drain or remove a pathological gall-bladder, and our attitude is, "Would you drain an infected or fibrosed appendix?" Now, would you? Provided, of course, that the condition of the patient, or technical difficulties, did not make it a hazardous procedure. This statement, of course, does not apply so directly to the common duct obstruction from stone or some growth. Here the surgeon's skill and experience will determine which will be the most likely to relieve his patient. In chronic cases in which we remove the gall-bladder we are now, in selected cases, closing without drainage, using the technic described in a previous communication.⁶ We have little fear from bile leakage in the chronic type, but in acute cases the virulence of the infection or hemorrhage from pericholecystitis may lead to the use of drainage.

Another great factor in leading us to do cholecystectomy is that we feel that while stones may re-form, a large number of the secondary operations where stones are found are really stones overlooked in a pouch so often at the neck of the gall-bladder, lying retroperitoneally and on top of the common duct. Such an oversight is impossible in removing the gall-bladder because this pouch has to be dissected free before one can proceed.

Again secondary operations on the gall-bladder in our hands have been nothing like as satisfactory because of the adhesions which have formed, hence let the diagnosis be made at a time when it is safe to deal with the existent pathology radically and for all time.

The histological findings in the specimens removed have largely been

CHOLECYSTITIS

characterized by destruction of the mucous membrane in various degrees, from an erosion of it at the tips of the papillæ to a complete disappearance in the old chronic case containing stones; the fibrosis and round-celled infiltration being in direct ratio to the amount of destruction of the mucous membrane.

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A METHOD OF PERMANENT GASTROSTOMY *

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OF PHILADELPHIA

AN incision is made from a point just below and to left of the ensiform cartilage downward parallel to the median line for three or four inches. About two or two and a half inches to the left of this incision a second cut is made, the upper end of which is on a level with the upper end of the first incision, the lower end of which is on the level with the lower end of the first incision. The lower extremities of these incisions are connected by a transverse incision (Fig. 1). The rectangular cutaneous flap thus outlined is dissected free, as far as its base, from the subjacent deep fascia, and the two long margins sutured together with catgut over a catheter (No. 20 F.), the eye of which remains uncovered below the lower end of the flap (Fig. 2). The catheter with its enveloping skin is drawn to one side, the underlying rectus muscle split longitudinally, and a portion of the anterior wall of the stomach drawn from the abdominal cavity. A small transverse opening is made in the exposed gastric wall, the inferior extremity of the catheter pushed into the stomach through the opening, and the rim of the lower end of the dermal tube enveloping the catheter sutured with catgut to the edges of the opening in the stomach. The lower half of the dermal tube is buried in the wall of the stomach in the same manner as the catheter is buried in the Witzel operation (Fig. 3). The upper end of the canal thus formed by the inversion of the anterior wall of the stomach is sutured to the abdominal wall, and the split rectus muscle approximated with catgut around the upper half of the dermal tube. The skin about the raw surface which remains is undermined, and, beginning at the lower left corner of the oblong defect (Fig. 1, *B*), sutured, the sutures being inserted farther apart on the right (*i.e.*, on the line *BCD*, Fig. 1) than on the left (*BA*, Fig. 1), until the lower margin of the external orifice of the dermal tube is reached, when the suture line bifurcates to embrace the new stoma. The scar thus resembles a Y, the long tail of which is slightly convex toward the median line (Fig. 4). The catheter is fastened to the skin with a catgut suture and should remain in place until the completion of healing, after which it may be withdrawn, to be reinserted only at the time of the feedings.

This method of gastrostomy is designed for those patients, usually suffering from irremovable cesophageal carcinoma, who must for the rest of their lives be nourished through an artificial opening in the stomach. The operation is a trifle longer than the Witzel operation, but has all the advantages of providing a canal lined with epithelium, which will not become agglutinated during the intervals between the insertions of the catheter. Further, there is no danger, as in the Witzel operation, of leakage between the outer

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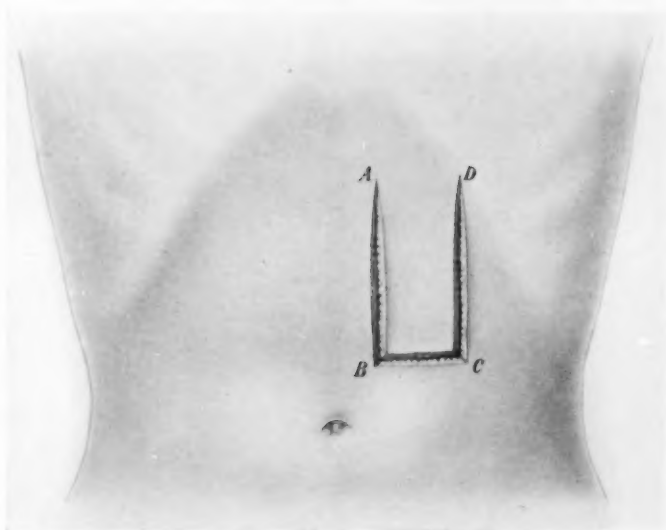


FIG. 1.—Gastrostomy. The cutaneous incision.

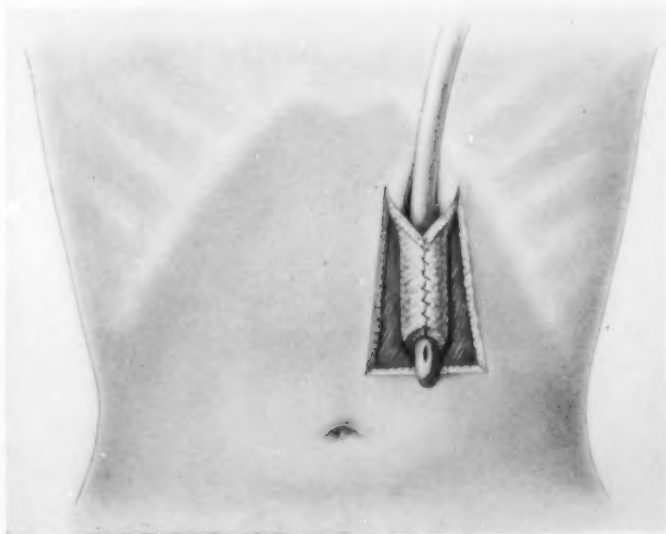


FIG. 2.—Gastrostomy. Formation of the dermal tube.

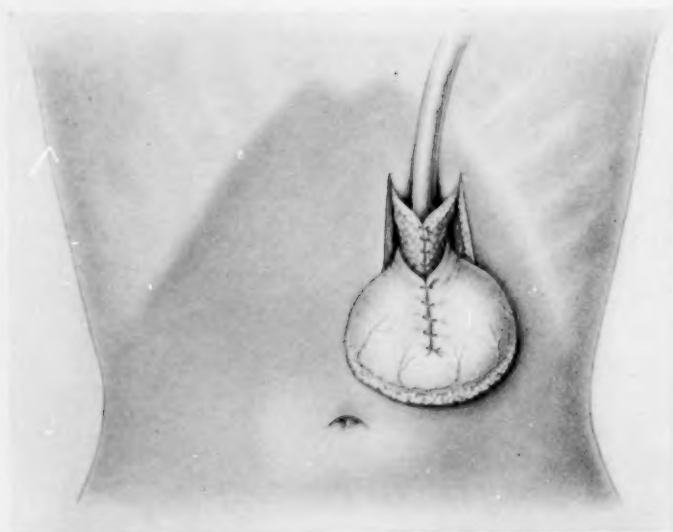


FIG. 3.—Gastrostomy. Envelopment of the dermal tube by the anterior gastric wall.

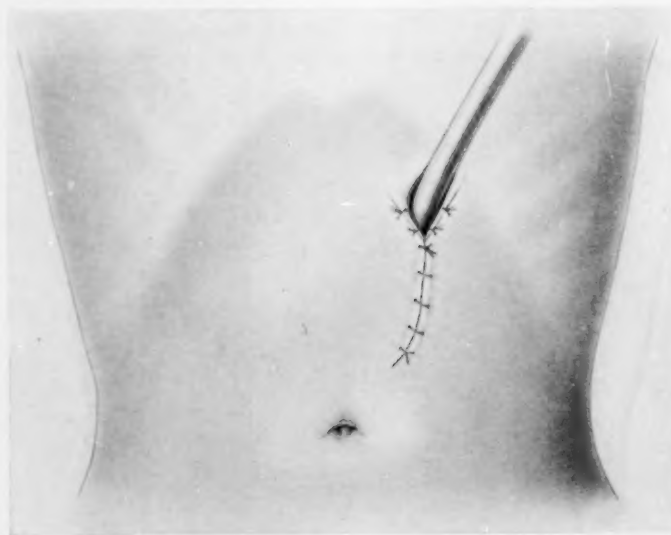


FIG. 4.—Gastrostomy. Cutaneous incision closed.

A METHOD OF PERMANENT GASTROSTOMY

end of the canal in the stomach and the abdominal wall, and no danger of pushing the catheter between the stomach and the abdominal wall and so into the peritoneal cavity.

A canal lined by mucous membrane can be constructed, as suggested by Depage, Jianu, and others, from a flap of the wall of the stomach, and is to be preferred to all other methods of gastrostomy when one desires to build an artificial œsophagus, which, later, is to be joined to the external stoma of the canal leading into the stomach, but in the majority of cases of œsophageal occlusion the building of a new œsophagus is not indicated, and to fashion a mucosa-lined canal from the gastric parietes is more complicated and attended by greater risks of infection than is the operation described above.

In the Ssbanejew-Franck operation, which also provides a lining of mucous membrane for the canal opening into the stomach, one must often, in view of the small size of the stomach consequent upon the œsophageal obstruction, pull almost the whole stomach from the peritoneal cavity, thus producing serious deformity, before securing the requisite amount of gastric wall to complete the operation. In addition, the external orifice of the canal retracts beneath the skin and becomes difficult of access, thus rendering catheterization uncertain and attempts at catheterization dangerous.

We have performed the operation which is the subject of this paper five times. One patient died at the end of ten days from pneumonia. Three lived for periods ranging from three to six months. One lived one year, dying of suppurative cholangitis. This patient had an ulceration of the gullet which was diagnosticated as carcinoma. After several months of œsophageal rest, however, the ulcer healed and swallowing became easy. The gastrostomy was therefore no longer kept in use and its lumen gradually contracted, so that at the end of a year only a fine probe could be introduced.

SPASTIC ILEUS (SPASMODIC INTESTINAL OBSTRUCTION) *

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AN ordinary classification of obstruction of the bowels is into mechanical and dynamic, the latter including both muscular spasm and muscular paralysis. Considering, however, the real meaning of the word dynamic, it is more accurate to adopt three divisions, mechanical, dynamic and adynamic, as is done by Ashhurst and others; and it would probably be better still to speak simply of mechanical, paralytic and spastic ileus, which would admit of no misinterpretation.

Obstruction from spasm of the constrictor muscles of the bowel is usually put down in text-books as a rare occurrence, when it is mentioned at all. If it received the attention it deserves, it would undoubtedly be recognized more frequently. A little reflection upon the permanent character of mechanical obstructions can hardly fail to convince one that most cases of enterostenosis recovering spontaneously, or under the use of eserine, belladonna, electricity, etc., are really spastic in origin.

Enterospasm as a cause of serious obstruction was first emphasized by Haidenhain about twenty years ago. Many surgeons at once denied its existence; but since then a sufficient number of cases, supported by operative findings, have been reported to establish its actuality beyond question. In fact, its possibility should be evident from the frequency of pyloric spasm and that of the lower end of the œsophagus, to say nothing of spastic contractions of the small intestine occurring in lead-poisoning, tabes dorsalis, and hernia. The literature of the subject is comparatively meagre, an occasional article appearing here and there in American and foreign journals. In 1902 Langenak collected 12 cases, only 2 of which had been proven by operation, and even as late as 1915 Mathews could find but 21 reports fully substantiated by laparotomy or by autopsy.

Spastic ileus is due to a spasmodic muscular contraction of a portion of the intestinal tract. It may affect either the small or the large bowel or both; in one place usually, or possibly in many places. It generally includes a few inches of the gut only, although at times a considerable length is compromised. A common location is the lower portion of the ileum. The typical appearance is striking and unmistakable. A section of gut a few inches in length is contracted to the limit, rendering it white, bloodless, and so firm that it often may be picked up by one end and held horizontally without bending. The contracted part does not merge gradually into the adjacent bowel, but stops abruptly at either end, the rest of the intestine remaining normal (see Fig. 1); but if the trouble lasts long enough the proximal bowel dilates, as in any other form of obstruction. The spasm

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SPASTIC ILEUS

frequently persists after the abdomen is opened, although it may disappear, and it is sometimes found even at autopsy.

Some surgeons (Körte, Wilms) insist that there must be a coincident paralysis of the remaining bowel, or the spasm would be overcome by peristalsis; but if this were true it would be hard to account for the instances in which invagination occurs, as there would be nothing to impel the intussusceptum into the intussusciens. In this connection it should be noted that local spasm is probably the first stage of intussusception (Nothnagel), and many supposed cases of this difficulty that recover spontaneously are possibly instances of spasm only. When invagination occurs it is facilitated by the fact that the bowel stiffens and elongates as it contracts, thus forcing itself into the distal segment.

The origin of spastic ileus is involved in considerable obscurity. There are those who wish to attribute it to local causes—irritation of the peritoneal or mucous surfaces, contusion of the external abdomen (Trendelenburg), or even severe muscular strain. Others prefer to assume that the sympathetic system or the vagus is the seat of the difficulty, while still others lay the blame upon the central nervous system alone (hysteria, neurasthenia, tabes dorsalis, etc.). Payer discards the nervous system altogether, at least in post-operative cases, and insists that the trouble is due to emboli originating in traumatic thrombosis of the omental and mesenteric vessels.

No one of these theories will fit all cases, just as no single explanation will cover all instances of muscular spasm elsewhere.

The local-irritation theory is based upon the existence of the sympathetic plexuses of Meissner and of Auerbach in the submucosa and between the muscular layers of the bowel, which are supposed to be very susceptible to irritation of the mucous lining. It is supported by experimentation on dogs; and in the human such spasms have been observed in connection with the presence of gall-stones, ulcers, round-worms, incarcerated herniæ, and also bacterial and other poisons. The contraction has even been seen to shift from one point to another with movement of the foreign body. This solution of the problem seems less clear, however, when we take into consideration the multitude of operations performed in which the bowel is traumatized in every conceivable manner, and also the vast number of indigestions continually taking place, without diminishing the rarity of spasmodic ileus. In addition, if irritation is assumed to be the cause, it does not explain why opening the abdomen and handling the intestine should relieve the spasm, as it often does, or why spasm should take place with comparative frequency in breast-fed infants. It is likewise difficult to understand how a traumatic lesion of one part of the intestinal canal can produce spasm in another more or less remote portion, as has been observed by Haidenhain, Miller and others; and also why it should occur at times from twisting of the pedicle of an ovarian tumor or pinching of a testicle within the inguinal canal. Such phenomena are more readily explained by the assumption of a reflex nervous action. Hence if direct irritation is to be

considered, we must assume some other factor, such as a lack of local or general resistance, which, as in so many other conditions, does not explain much.

Beyond its mere possibility, there is not much to support the assumption that the trouble originates in the sympathetic or in the vagus. To be sure both these nerves, especially the former, supply the digestive tract, but this does not make it clear why they should cause a local spasm; in fact, if either one of them were at fault it would seem more likely that contracture of an extensive segment of bowel would result instead of a few inches only. This same objection also applies to the central nervous system.

In support of the theory of central origin, it is argued that spastic ileus is found in neurotic and hysteric individuals, Hawkins stating that "its dependence upon the mental state is not to be doubted." While this is probably true to a certain extent, it may not mean more than that such people have a nervous system which responds easily to stimuli. And in addition, a number of cases, including my own, have been reported in infants too young to be accused of hysteria or a "mental state" of any kind.

Payer's embolic theory can be made to apply to but few except post-operative or traumatic cases with injury of the omentum, and then it is supported by comparatively little direct evidence.

Hence the best we can say at present is that spastic ileus is a reflex nervous spasm of the bowel, due to some irritation in the immediate vicinity, or in some more remote portion of the abdomen or the body, and often determined by an especially susceptible condition of the local nerves or the central nervous system. Why it should occur in a few individuals and not in many others, and why it should usually affect a small section of the bowel only, we are not in a position satisfactorily to explain.

It is important to know that spastic ileus may follow any sort of abdominal operation, either immediately or a number of days subsequently. That it also may occur after operations near to but not within the peritoneal cavity seems to be shown by a case of my own in which a right nephrectomy was performed for pyonephrosis in a man of nervous temperament. The appendix had been removed some two weeks previously, and the gall-bladder, stomach and other organs examined and found to be normal. The patient did well for four or five days and then suddenly developed an extremely severe colicky pain near the umbilicus, accompanied with nausea and pale and clammy skin. Repeated enemata failed to produce either gas or fecal material. The temperature was normal and the pulse remarkably slow (this slow pulse has been emphasized by Haidenhain, who thought it might be due to irritation of the vagus). The attack lasted for more than twenty-four hours, slowly disappearing under the use of morphine.

Aside from other considerations, it is useful to realize that spasm may cause intestinal obstruction, because it helps to explain those cases in which the abdomen is opened and nothing is found. If we are able to say before-

SPASTIC ILEUS

hand that an ileus may be due to spasmodic contracture, a possible post-operative embarrassment may be avoided, and, armed with this defense, we may be encouraged to operate earlier, thus avoiding dangerous delay.

The symptoms of this imperfectly understood trouble are always those of intermittent obstruction of varying intensity and duration. Some instances are so acutely severe, with vomiting, constipation, shock, feeble pulse, leaky shin, etc., that death may rapidly occur; while others merely give rise to occasional abdominal pains, during the course of weeks, months or even years, without the development of more serious results than recurrent constipation. Between these extremes are a multitude of obscure cases that may tax the diagnostic ability of the surgeon to such an extent that many escape detection or are confused with chronic appendicitis (Hawkins) or other troubles.

It is seldom easy to differentiate between spastic and mechanical ileus, except in manifestly hysteric individuals, although the symptoms of spasm are often less severe and are apt to occur intermittently, which should arouse suspicion. In acute cases, where an immediate decision is demanded, it should always be made in favor of the mechanical form, for fear of dangerously delaying an operation.

If spastic ileus could always be recognized the treatment would be comparatively easy, especially in the less severe cases, consisting principally in the administration of such antispasmodic remedies as morphine, atropine, chloral hydrate, the bromides, etc., together with hot fomentations and enemata of various kinds. If the symptoms are, however, at all urgent, one should not dwell upon the refinements of diagnosis, but proceed to operation at once. Delay is apt to be fatal if the obstruction is mechanical, and might even be so if it were merely spasmodic. When a spasm is found to be the cause of the obstruction, experience seems to show that considerable reliance can be placed upon its disappearing while the abdomen is open, or shortly after it has been closed. Why this should occur it is difficult to explain. It may be due to the mere opening of the peritoneal cavity, or to the coincident handling of the bowel. We know it is not the anæsthetic, because the spasm often persists throughout the operation in spite of profound anæsthesia. Hence, if the patient is in reasonably good condition, one may perhaps venture to close the abdomen, as has often been done, trusting that the spasm will disappear, from the combined effects of the operation and the subsequent administration of antispasmodics. But if the patient is in bad condition, with regurgitant vomiting from a paralyzed bowel, a poor pulse, subnormal temperature, etc., it will be necessary to obtain more certain relief, which can be done by establishing a fecal fistula above the obstruction, although even this may not suffice. (In a case reported by Pankow such a fistula had to be left open for two months, owing to persistence of the spasms.)

Anyone who has operated in spastic ileus must have been tempted to resect or short-circuit the contracted portion of bowel, and I believe this

would occasionally be justifiable, in severe cases at least, because the risk of doing harm is but slight and the ultimate results of the let-alone policy have been unsatisfactory, owing to a tendency to recurrence. There is, however, no precedent for such a radical procedure, and there can be no certainty, with our present knowledge, that the spasm might not recur elsewhere.

CASE.—The following is a report of a typical instance of spastic ileus, occurring in a breast-fed female infant, about six months old. After remaining well for the first two weeks after birth, an intestinal indigestion occurred, with a moderate amount of mucus in the stools. Although this soon subsided, the colicky pains accompanying it persisted, in spite of medicinal and dietetic treatment administered by Dr. J. W. Amessee.

The pains were peculiar in that they came in spells at irregular intervals, lasting from a few minutes to many hours. Between the attacks the patient was well and happy, for hours or even days at a time, with normal stools, digestion and appetite. Then, without apparent cause, the abdomen would become rigid, the lower limbs draw up, and the patient scream, and roll about in agony. There was no vomiting, no diarrhoea, and no rise in temperature. Neither fecal movements nor expulsion of flatus could be obtained, so that abdominal distention would result if the attack lasted long enough. Repeated examinations revealed no abnormalities of the lungs, or of the nervous or circulatory systems, except a heart murmur which persisted for three weeks and then disappeared. An X-ray picture of the intestinal tract, taken between the attacks with the aid of bismuth, revealed nothing.

I first saw the case, with Doctor Amessee, at the end of the fourth week of the disease. A tentative diagnosis was made, of "partial intermittent intestinal obstruction, of unknown origin," and an exploratory laparotomy decided upon, in spite of the tender age and weakened condition of the patient. This was performed, under ether, on December 22, 1917, through a right, median, rectus incision.

A careful examination was made of the contents of the abdomen, including the stomach, the large and small intestines, the liver, gall-bladder and the spleen. Nothing abnormal was found except a marked spasm of a segment of the lower ileum, about 5 or 6 inches in length, which was white, bloodless, contracted to the size of a slate-pencil, and so rigid that it could be picked up by one end without bending. The peritoneal covering was normal, and nothing could be felt within the lumen of the bowel. The intestine above this narrow place was moderately dilated, and that below slightly smaller than normal, the contracture ending abruptly at either extremity by a sharp wall.

Although it seemed sufficiently evident that the cause of the trouble had been discovered, it was not so clear as to what should be done. Entero-anastomosis and resection were both considered, but the condition of the patient was such that further operative intervention had to be abandoned and the abdomen closed. Although there was considerable shock, a rapid recovery took place, and the child was relieved of

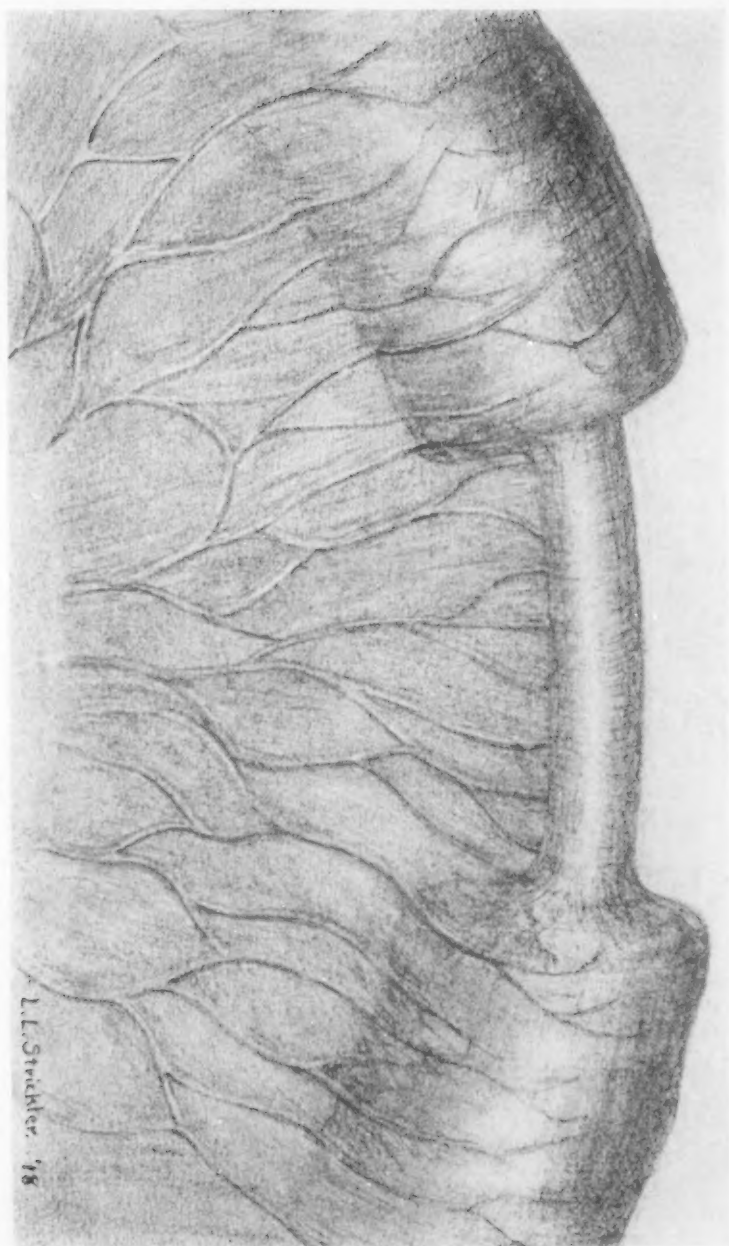


FIG. 1.

U.S. GEOLOGICAL SURVEY
WASHINGTON, D.C.



SPASTIC ILEUS

its trouble. For a month it remained well, gaining an average of a pound a week. At the end of this time an acute indigestion developed, with violent pains, the child dying within twenty-four hours, apparently from a recurrence of its original trouble (Doctor Amessee).

Recently I operated (July 24, 1918) upon a man of sixty-two who had "always" suffered from constipation which had gradually become almost an obstipation. A radiogram, taken by Dr. Childs, showed marked ileal stasis (96 hours). Within the last six years he had developed epilepsy with frequent nocturnal and diurnal attacks, together with hebitude of mind, loss of memory and many nervous symptoms. Believing that the nervous phenomena might be due to the intestinal stasis, a laparotomy was done and a very decided "Lane's kink" found and rectified. During forty-eight hours following the operation his condition was satisfactory. Then distention and vomiting occurred and he died suddenly in a violent epileptic convulsion.

An autopsy revealed no peritonitis, but an extreme spastic contraction of the entire large intestine (which was found dilated at the operation) and the terminal twelve inches of the small bowel, which was greatly and suddenly dilated above this point. The entire contracted bowel was quite firm and not larger than a fountain pen, except in the region of the cæcum, which was not much larger.

An explanation of the condition would be that the long-existing intestinal toxæmia had not only caused general epilepsy together with other nervous symptoms, but had finally given rise to a fatal spastic ileus.

SUMMARY

1. The best classification of intestinal obstruction is into mechanical, paralytic, and spastic. The last named is considered rare, but is undoubtedly more common than is generally recognized.

2. The causes of spastic ileus are not clearly understood, but they are probably various and act reflexly through the nerves.

3. In this form of obstruction, a section of bowel, often only a few inches in length, becomes so firmly contracted that it is hard, white and bloodless, so that it often can be picked up by one end without bending.

4. The symptoms are intermittent. They may be acute, dangerous and severe, as in mechanical obstruction, or mild and chronic, merely causing occasional pains and constipation.

5. Where there is doubt about the diagnosis, it should always be made in favor of mechanical obstruction, for fear of a mistake leading to fatal delay in operating.

6. Hence the treatment is nearly always initiated by a laparotomy. When the condition is clearly understood, following an operation or otherwise, antispasmodics, such as morphine, atropine, etc., can be administered.

7. Mere opening of the abdomen generally relieves the spasmodic contraction for a greater or less length of time, but it may return with possibly fatal effect.

8. Hence it might be well to short-circuit the section of spastic bowel,

LEONARD FREEMAN

although there is no precedent for this and no guarantee that the spasm might not recur elsewhere.

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RIGHT COLECTOMY*

By GEORGE W. W. BREWSTER, M.D.
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THE object of this paper is to make a preliminary report of the results in a series of nineteen operations in which the right colon was excised for relief of symptoms which were attributed to blocking of fæces in the cæcum and as a basis of certain personal observations. I have no intention of discussing the general subject of stasis or the question of its surgical treatment. I have a full realization of the confusion as to indications for operation and the difficulty of determining the actual results following operations for so-called intestinal stasis. I feel that this is a distinctly dangerous subject to deal with without being grouped with those surgical enthusiasts who have recklessly resected colons and unhesitatingly anastomosed the ilea to various segments of the sigmoid and rectum. While agreeing in the main with the opinion expressed so completely by Bevan before this Society a year ago and his condemnation of all operations for functional disturbances of large intestine, I have felt that there might be a condition of abnormal dilatation of the cæcum resulting from partial obstruction in the colon beyond in which resection might be justified. This series of cases represent a group taken from the Massachusetts General Hospital, as a special assignment, and those referred to me by private physicians. Each case had been under careful study and observation by competent men, and in each case there was thought to be a condition, unrelieved by previous treatment, which justified exploration. The question of excision was to depend upon operative findings and only undertaken when the location, mobility, size of cæcum, and existence of bands and adhesions seemed to point to a possible condition of partial obstruction. The operation was undertaken with a clear understanding of the cloudiness of the subject of stasis with the hope that not only might the patients be benefited but that the writer might obtain some personal impressions as to the true amount of benefit to be expected in this type of case, and have some standard as to the type of case which would not be benefited. Uncertain as this subject is, the writer has felt that there are some cases in which right colectomy might be the only method of relief.

The group of cases representing those operated on at the Massachusetts General Hospital were referred to me for operation for relief of more or less severe and unrelieved constipation with evidence of X-ray and clinical symptoms that the region of the cæcum was the location of the cause. Most of these cases have come from the nerve department because of the work being done there in connection with the relation between epilepsy and chronic intestinal stasis.

The other cases operated were referred by private physicians who had

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GEORGE W. W. BREWSTER

become convinced that the cause of partial invalidism was due to abnormal delay in cæcum and that exploration with possible excision was justified.

Operation, therefore, was undertaken for definite symptoms of intestinal obstruction as demonstrated by marked constipation, palpable masses in the right iliac fossa, distention, and X-ray demonstration of stasis in the ileum and cæcum. The right colon was excised in those cases in which mechanical obstruction was found. Pathological study of many of the specimens has been made and nothing abnormal demonstrated. Many of these cases had had a previous appendectomy for chronic right-sided symptoms without relief.

In these nineteen cases I have discovered nothing new in the method of technic and have followed out the suggestions of other operators. The mobilization of the colon as described by Mayo simplifies the procedure; and lateral anastomosis with clamps reduces the chances of sepsis to a minimum. In all of these cases the same method had been adopted, and the only complications in the convalescence have been the infection of two of the abdominal incisions with suppuration in the abdominal wall. All have passed through an unusually favorable convalescence; there has been no case with gas distention or difficulty from postoperative ileus. In fact, it has been noted by the house staff that these cases have had less discomfort with gas than in many of the other less extensive abdominal operations. I think the method of suture is not of great importance and may be left to the individual preference of the operator.

The absence of postoperative distention has led me to feel that attaching the site of suture to the abdominal wall is unnecessary.

I believe that the immediate result in this operation is influenced largely by two facts; first, that there is almost no handling of the intestines or abdominal contents except of the segment which is subsequently entirely removed, and, second, the avoidance of infection.

Decision to operate on these cases rests both upon the clinical observation of a group of symptoms, which in my own operative experience I have seen relieved by such an operation as is here described; and upon the demonstration of a cæcum abnormally mobile, with obstructing adhesions distal to the dilated portion. Such apparent abnormalities have been found in all of the reported cases and resection has not been undertaken unless such factors were demonstrated.

The statement of results is based upon examinations and reports of the patients. The fact that preoperative symptoms have been relieved is accepted as proof of the benefit of the operation.

One case was that of a young married woman, three months pregnant, who, ever since an ileosigmoidostomy by another surgeon two years previous, had had intermittent attacks of vomiting, nausea, and abdominal distress, all much aggravated during the pregnant period. Her condition was reduced to such an extent that some interference was deemed absolutely necessary. I felt that either the short circuit should be undone or that some operation should be undertaken to relieve the backing up in the cæcum. I found a large, dilated cæcum with a long

RIGHT COLECTOMY

mesentery lying free in the right side and forming a green colored pouch filled with pasty fecal matter. The ileum was cut off the sigmoid and the opening closed, a lateral anastomosis was then done between the ileum and transverse colon near the beginning of the omentum, and the right colon excised. This patient made an uninterrupted recovery from the operation with no vomiting and with very marked improvement in the general condition. Subsequent history in the following two months showed a gain of fifteen pounds with no return of the symptoms which antedated the operation. All of the original symptoms unrelieved or made worse by the ileosigmoidostomy were now relieved as was also the persistent vomiting. The pregnancy was normal and uninterrupted in its course.

I will speak of one other case, a child who had been operated on in another clinic for acute appendicitis a year previously and a condition of colitis found which led to the making of an appendicostomy for irrigation of the colon. After irrigation for eight months with some improvement in the general condition, there developed symptoms of obstruction and general nervous attacks which were attributed by the attending physician to backing up in the region of the cæcum. The patient was referred to me by a very careful internist who was convinced that the child was suffering from an abnormal condition in the cæcum. On opening the abdomen the cæcum was found adherent to the abdominal wall, much dilated at the lower end, with an unusual number of adhesive bands along the ascending colon and especially at the hepatic flexure. I excised the cæcum and anastomosed the ileum to the transverse colon. This child, three months after operation, shows a striking improvement in general condition. He has been entirely relieved of his previous symptoms and has gained steadily in weight, eats normally for his age, and has daily normal movements of the bowels.

This case does not prove that operation was indicated or that the operation was necessary as far as any pathological condition found or demonstrated; but to the physician who had the case under observation, and to myself, it is shown that the operation has been the cause of the child's improvement and that the condition existing before operation was the cause of the symptoms of chronic invalidism.

In summing up the result of the operations in the nineteen cases, I am convinced that in cases of right-sided obstruction with stasis in the cæcum or ileocaecal region the result of mechanical or apparent mechanical causes, if unrelieved by any palliative method of treatment, may be successfully cured by resection of the right colon. I do not feel that it is yet possible to collect absolute data as to what signs justify operation and in what cases it is indicated. The immediate result of the operation shows it is an operation which can be done without undue risk: twenty cases reported by Mayo, twelve by Johnson, and this series of nineteen, without a mortality.

Twelve of these cases were epileptics in which there were symptoms of obstruction manifested by extreme constipation or recurring attacks of right-sided pain with distention and masses in the cæcum. Operation was

GEORGE W. W. BREWSTER

undertaken, primarily, for relief of a possible mechanical partial obstruction, causing dilatation of the cæcum and backing up of the intestinal contents.

Although a majority of these cases have been largely relieved of the constipation and have shown a marked improvement in their general condition, there has been slight if any change in the epileptic attacks. It is only fair to state, however, that the physician who had these cases under his personal care and observation feels that it is impossible to make more than the preliminary statement, that the operation has been of some benefit, and that there are possibilities of more definite results in the future. At the present time no case has shown any unfavorable condition as a result of the operation. In other words, if the operation has been of no benefit, it has not been followed as yet by a condition worse than that which preceded it. So far as epilepsy is concerned, unless symptoms of obstruction in right colon were found to be of a mechanical cause, I should not feel that operation was indicated.

In five cases in which a large, dilated cæcum was found with adhesive bands producing apparent constriction of the ascending colon and hepatic flexure or angulations with adhesions, there has been entire relief. Of these, three had recurring attacks of right-sided pain with constipation, and two had a persistent and incurable constipation.

In two cases, the relief of a condition of dilatation of the cæcum from backing up of intestinal contents following an ileosigmoidostomy was entirely satisfactory following excision of the cæcum and right colon and anastomosing the ileum to the transverse colon. The study of these seven cases shows that in six there is entire relief of former symptoms, in one only partial relief.

The relief of symptoms has been so marked that I am inclined to believe that the condition of the cæcum was abnormal, and that there was some abnormal obstruction of the ascending colon or hepatic flexure, and that the operation was indicated.

The condition of the cæcum was thought, by the operator and by those present, to be abnormal, but it has been impossible for the pathologist to show anything abnormal in his examination of the specimens. Even the decision as to whether there were abnormal adhesions or bands is open to question, for I have certainly found similar conditions in patients without symptoms.

I confess that the immediate results were so satisfactory that signs may have been too quickly interpreted as justifying excision in some of the nineteen cases.

CONCLUSIONS

1. Although right colectomy has been reported by others without mortality and my personal experience has added a series of nineteen cases with favorable results, it is an operation which in a large series of cases may show a definite mortality of considerable percentage.

2. In spite of the very satisfactory outcome in certain of these cases,

RIGHT COLECTOMY

the writer feels that the operation is too serious to be undertaken except for very definite conditions of incurable partial obstruction.

3. The indications for excision are dilatation of the cæcum, extreme mobility, presence of adhesions in patients unrelieved by any palliative treatment and whose symptoms lead to chronic invalidism.

BRIEF OF CASE REPORTS

CASE I.—R. P., aged eleven years. November 6, 1915. Referred by Doctor Ward, of Lynn. Operation performed for dilated cæcum and stasis associated with epilepsy. Large dilated cæcum, chronic appendix, adhesions in the hepatic flexure. The terminal ileum, cæcum, and two inches of the transverse colon excised. Lateral anastomosis done between the ileum and transverse colon.

Good recovery from the operation. Return of the epileptic seizures after two months.

CASE II.—Mrs. A. C., aged forty years. February 6, 1917. Dr. J. M. Jackson, of Boston. Appendix removed in 1905. Operation in 1915 for fibroids. Since that time has had symptoms of stasis, dilatation of the cæcum with pain in right side. Patient had become chronic invalid.

X-ray before operation showed movable, low cæcum, some ileal stasis.

Operation.—Large movable cæcum found, adhesions along the hepatic flexure, incompetent ileocæcal valve. Removal of right colon; anastomosis of the ileum to transverse colon.

This patient made a perfectly satisfactory recovery.

Report May, 1918. Entirely relieved of symptoms existing before operation.

CASE III.—F. E. F., aged twenty-two years. July 20, 1917. Referred by Doctor Drowne, Boston. Has had epileptic seizures since childhood. Has improved under Doctor Drowne's care.

X-ray report is hepatic flexure abnormally sharp angle, sigmoid large and high, definite stasis at hepatic and splenic flexures suggesting traps in these two places.

Operation for stasis. Right colectomy done.

This patient made a very satisfactory recovery from the operation, and general condition was markedly improved. There has been some diminution in the severity of the epileptic seizures. Patient and family convinced that operation has been followed by marked improvement.

CASE IV.—Mrs. J. B. A. September 25, 1917. Referred by Doctor Dewis, Boston. Was referred to me for operation on account of persistent vomiting and nausea following operation for ileosigmoidostomy two years ago.

A large movable mass felt in right iliac region. Patient in poor condition.

Operation.—A large dilated cæcum, freely movable, partly filled with faeces, found. Anastomosis of the ileum to sigmoid was excised, opening in sigmoid closed. Right colon excised. Ileum anastomosed to transverse colon.

This patient made a perfectly satisfactory recovery and was entirely

GEORGE W. W. BREWSTER

relieved of symptoms of obstruction. Gained fifteen pounds in three months. Went through normal labor seven months after operation.

CASE V.—Mrs. J. C. B., aged fifty-two years. September 25, 1917. Referred by Doctor Swaim. Had an ileosigmoidostomy five years previously for stasis and symptoms of absorption. On account of the return of the symptoms which seemed to be due to stasis she was referred to me for operation.

A dilated cæcum could be palpated on the right side.

Operation.—A large dilated cæcum partly filled with fecal matter was found, also a large cystic dilatation of the blind end of the ileum which had been anastomosed to the sigmoid by a lateral anastomosis. These two sacks were filled with fecal matter. The rest of the colon seemed to be in normal condition. Anastomosis was excised, opening in the sigmoid closed. Right colon excised, and a lateral anastomosis done between the ileum and middle of the transverse colon.

This patient has only been in part relieved by the operation. Still has symptoms which are attributed to stasis, although marked improvement in the ease with which the bowels are moved. On the whole, the patient is somewhat improved by this operation.

CASE VI.—Mrs. B. S. August 15, 1917. Referred by Doctor Hewes, Boston. Referred to me for chronic constipation and symptoms attributed to partial obstruction.

Operation.—A dilated, movable cæcum found with adhesions along the hepatic flexure. The cæcum was excised, and a lateral anastomosis done between the ileum and transverse colon.

Report May, 1918. This patient made a most complete recovery, and is entirely relieved of all former symptoms.

CASE VII.—Miss L. P., aged eighteen years. October 26, 1917. Referred by Doctor Drowne, Boston. Sent to me for removal of colon on account of stasis and epilepsy.

Operation.—Right colectomy done with lateral anastomosis between ileum and transverse colon.

No improvement in this patient's condition since operation.

CASE VIII.—E. W., boy three and a half years old. February 14, 1918. Referred by Doctor Hamilton. Has had appendicostomy opening for a year. Referred to me now by Doctor Hamilton for removal of part of the colon for stasis.

Operation.—Many adhesions found about old operative wound, dilatation of the cæcum. Two inches of the terminal ileum and right colon excised. Lateral anastomosis done between the ileum and transverse colon.

This patient made uninterrupted recovery with entire relief of pre-operative symptoms.

Report in May, 1918, from mother that child is now perfectly normal.

CASE IX.—D. S. G., aged twenty-five years. March, 1918. Referred by Doctor Sturgis, Lynn.

Referred to me for operation on account of epilepsy associated with intestinal symptoms.

RIGHT COLECTOMY

Operation.—A right colectomy was done with anastomosis of the ileum to middle of transverse colon.

This patient made an uninterrupted operative recovery. Reports that there is enough improvement in general condition to resume work. No attacks as yet, May, 1918.

CASE X.—M. G., aged eight years. November 7, 1917. Epileptic since birth. Attacks associated with intestinal stasis. X-ray shows dilatation of the cæcum and adhesions or some cause of stoppage in the ascending colon.

Operation.—Cæcum enlarged and with a long mesentery, cæcum freely movable and easily transposed to left side; appendix somewhat thickened; ascending colon at hepatic flexure tied down by many adhesions; first part of transverse colon formed a U and held by adhesions. Cæcum and ascending colon mobilized. Resection of right colon and lateral anastomosis between ileum and transverse colon.

Specimen showed dilatation of cæcum and mechanical obstruction from adhesions.

Good recovery from operation.

Report May, 1918. Improvement in general condition but recurrence of epileptic seizures.

CASE XI.—Hospital No. 218,244. Mrs. B. L. K., aged thirty years. October 25, 1917. Extreme constipation for years. Has always been thin and poorly nourished. Occasional attacks of nausea and vomiting. General abdominal pain. Dizzy spells and many general nervous symptoms.

Lumps can be felt along course of the colon.

Operation.—Large freely movable cæcum. Many bands and adhesions along ascending colon and hepatic flexure. Resection of right colon.

Excellent recovery.

Report in May, 1918. Constipation entirely relieved.

CASE XII.—Hospital No. 216,895. Mrs. S. S. H., aged thirty-five years. August 21, 1917. Epilepsy; intestinal stasis; dilatation of the colon. Convulsions for twenty years. Always very constipated. X-ray shows dilated cæcum and ascending colon; high right angle hepatic flexure.

Operation.—Ileum adherent to brim of pelvis; many adhesions along ascending colon. Resection of right colon. Excellent recovery and convalescence.

Report in May, 1918. Constipation entirely cured. Great improvement in general condition. Still has epileptic attacks.

CASE XIII.—Hospital No. 216,907. Mr. K. N. S., aged twenty-three years. August, 1917. Epileptic attacks for five years. Attacks associated with indigestion and constipation. Has been taking enema at night and morning for past three months to prevent attacks, if enema is omitted attacks recur. X-ray shows unusually movable cæcum, slight ileal stasis. Colon low but otherwise negative.

Operation.—Freely movable cæcum; bands and adhesions along ascending colon; numerous enlarged mesenteric glands. Resection of right colon. Excellent recovery.

Report in May, 1918. Constipation entirely relieved. General condition markedly improved. Attacks persist.

CASE XIV.—Hospital No. 216,225. Mr. J. P. F., aged twenty-one years. July 19, 1917. Intestinal stasis. Epilepsy. X-ray shows low ascending colon. General ptosis of viscera.

Operation.—Large mobile cæcum; chronic appendix; many enlarged glands; bands and adhesions at hepatic flexure. Resection of right colon. Excellent operative recovery.

Report May, 1918. Attacks have recurred; not much change, although no worse.

CASE XV.—Hospital No. 216,006. Miss H. A. M., aged twelve years. July 12, 1917. Intestinal stasis. Epilepsy. Attacks of pain in right lower quadrant. X-ray shows large mobile cæcum.

Operation.—Mobile cæcum; long mesentery; chronic appendix; vascular adhesions over cæcum; enlarged glands. Resection of right colon. Normal convalescence.

Report in May, 1918. Still has attacks. Constipation markedly relieved.

CASE XVI.—Hospital No. 215,871. Miss A. T. July 2, 1917. Epilepsy. Intestinal stasis. History of constipation. X-ray shows mobile cæcum, colon low, otherwise normal.

Operation.—Large distended cæcum with long mesentery; chronic appendix with many adhesions about hepatic flexure. Resection of right colon. Good recovery.

This patient has been lost track of.

CASE XVII.—Hospital No. 215,481. Miss L. H. June 12, 1917. Severe constipation for twenty years. Recurring attacks of pain in upper abdomen. Poorly developed and nourished woman. X-ray shows general ptosis of all viscera; mobile cæcum.

Operation.—Cæcum dilated and movable; chronic appendix; adhesions of ascending colon. Resection of right colon. Excellent recovery from operation.

Report in May, 1918, six months after operation. Has made marked improvement and now feels cured.

CASE XVIII.—Hospital No. 215,062. Mr. T. M., aged twenty years. May 23, 1917. Epilepsy. Constipation and errors of diet bring on attacks. X-ray shows dilated terminal ileum, mobile cæcum and ascending colon. Resection of right colon with lateral anastomosis of the ileum to transverse colon. Convalescence normal.

Report in May, 1918. General condition improved. Attacks milder but still continue.

CASE XIX.—Hospital No. 213,196. Miss M. C., aged twenty-two years. February, 1917. Convulsive seizures for a year. History of marked constipation; constant dull pain in right lower quadrant, worse after seizures. X-ray shows intestinal stasis.

Operation.—Chronic appendix, movable cæcum, ascending colon covered with adhesions. Resection of right colon with lateral anastomosis of ileum to transverse colon.

Marked improvement in general condition. Convulsions still continue, attacks less frequent. Constipation entirely relieved.

FISTULA OF THE COLON *

By C. H. MAYO, M.D.

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ALTHOUGH fistulas of the colon fortunately occur but rarely, their occurrence is too frequent for the credit of the surgeon and the comfort of the patient. They are, however, apparently more common than they really are, because they are often considered as new cases in various clinics. Patients who are so unfortunate as to have fistulas, usually show the scars of numerous operations for their repair.

Practically all cases of fistula of the colon arise from infection, for the relief of which surgery is indicated; but few are caused by external trauma. Occasionally they result from injury of the intestine caused by the separation of adhesions, the surgeon overlooking a small perforation, or, the fistula is a sequel to an operation for the relief of obstruction. However, in these cases, if the bulk of the intestinal discharges are delivered normally, and if the opening is not absolutely necessary for relief or for the preservation of life, patients will readily undergo prolonged treatment or repeated operation for cure in preference to the fistula. Most of them are greatly distressed by the condition, and even a necessary colostomy is accepted only because it relieves the intense or prolonged suffering. The abdominal wall is very rarely perforated by infection. Such a condition, however, accounts for a small percentage of the cases in which fistulas occur in the lower abdomen, secondary to diverticulitis. In a few such cases perforation into the bladder takes place, while more rarely a fistula dissects its way along the rectum to the ischio-rectal fossa, for external discharge. Patients with the latter trouble are seldom cured, yet following repeated operation on the anal canal, they are sooner or later affected by permanent incontinence, in the presence of which the primary condition is unimportant, and really improves with the disappearance of the tension within the bowel. Curiously enough, these small abscesses perforating into the bladder, seldom cause much pain, and I have seen a few patients who complained of the passing of gas with the urine as the first symptom. The true diverticula are very tortuous and the point of perforation is not larger than a small knitting needle. I have not known these conditions to follow an acquired form of diverticulum. The patient's story is often considered incredulous, and it is believed to be impossible that such a condition should exist without the urine passing back into the rectum. The cystoscopist examiner often fails in his first examination. There being no back flow in the diverticulum, the use of methylene blue solutions in the bladder and the testing of the rectal contents is of no aid.

Through an abdominal incision it is easy to separate the fistula from the

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bladder and successfully to close it on the bladder side, but on the bowel side it must be dissected out of the wall of the intestine or there is danger of recurrence of trouble, not necessarily a fistula. In some cases the local disease of the sigmoid is so extensive that a resection of several inches of bowel is necessary. This is safely done as the three-stage Mikulicz operation, which, unfortunately, requires a considerably longer hospital attention than does the resection by suture, or the tube resection, in which the union is made over a large tube passed through the rectum and out of the anus. In cases of perforating diverticulitis, obstruction, a common symptom of the usual form of the disease, is not present. Years ago, when appendicitis was operated on in the acute stage in the majority of cases, cecal fistulas were common. None of the fistulas or colostomies are more difficult to care for than the wet cecal fistula. The change of bacterial flora from ileum to colon makes a great difference in the intestinal discharges. The practically odorless contents of the lower ileum is noted following the Brown ileostomy within six inches of the cæcum and is in marked contrast to the contents noted in the cecostomy. After the occurrence of a cecal fistula, the surgeon who does the primary operation for its closure should accomplish it through an ample abdominal incision on the inside of the fistulous opening.

OPERATION

Adhesions are separated, complications dealt with and the opening closed, but if the operation is the fourth or the sixth, and there is no obstructive symptom associated with the nuisance of the fistula, the simplest procedure, in order to avoid again dealing with the adhesions and poor intestinal areas for suturing, is to divide the ileum moderately close to the ileo-cæcal valve, invaginating the lower end and making an end-to-side anastomosis of the proximal end with the sigmoid (Fig. 1). In some instances this can be done with the transverse colon instead of the sigmoid. This immediately dries the fistula, and only occasionally is it necessary to add a few stitches after separating the mucous membrane from the skin to secure closure of the fistula. The operation is quickly done and is exceedingly satisfactory. Very rarely after these operations is there reverse peristalsis, causing an accumulation of fecal material in the cæcum and ascending colon. In such cases Ochsner's permanent mucous drainage is most effective. The colon is divided several inches proximal to the anastomosis, the lower end is closed and the upper end brought into the incision, reducing the size of its lumen around a small tube and leaving the mucous surface without invagination. The stump of the distal ileum is also brought into the wound so that the functionless large bowel may be emptied of its contents by irrigating through this; one fistula only remains and discharges but a little mucus each day. In a few instances in which I have been compelled, as a first consideration, to conserve the strength of the patient, I have found the method most satisfactory. There is no question but that many fistulas heal without operation, the types being those in which the fistulous opening

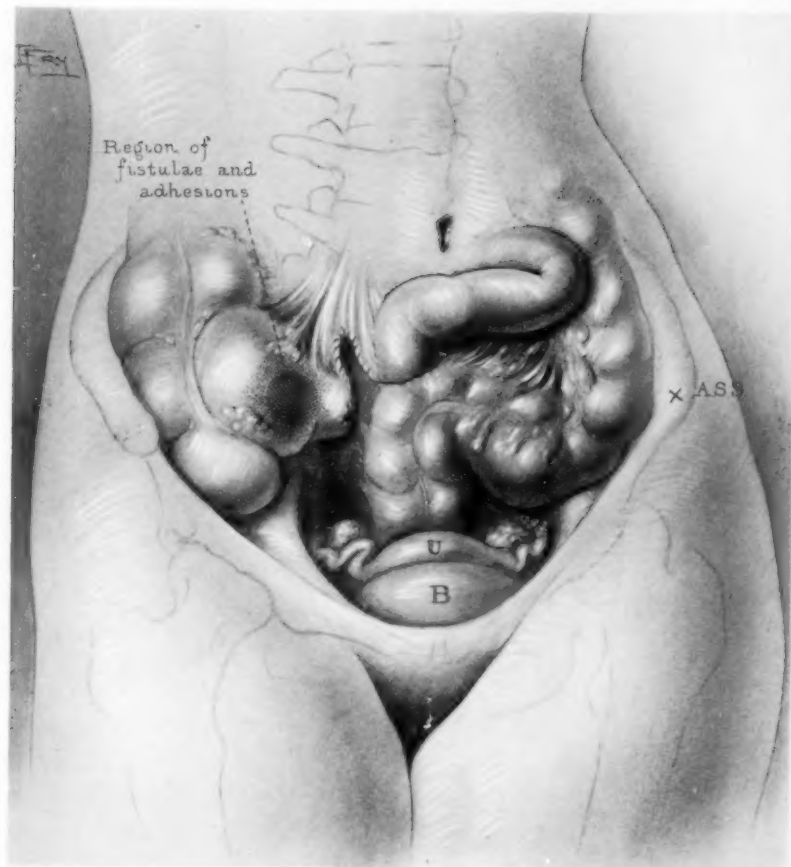


FIG. 1.

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FISTULA OF THE COLON

comes close to the parietal peritoneum without an intervening cavity, and this is true whether the fistula is in the vagina or through the abdominal wall. Injections of various pastes into these latter to aid in the healing is an unnecessary procedure, and in those with internal pockets such treatment is usually a waste of time except as a means of diagnosis with the X-ray, as they indicate whether or not a pocket is present.

Practical observations and many years of surgery show that most methods of closure or suture of the small intestine will hold, as it is easier to suture water-tight than gas-tight. A different bacterial flora is found here from that in the large intestine, and the patient, if need be, will die of obstruction or toxæmia before the suturing will give way; but the large bowel must be both gas- and water-tight. The most essential point in these operations for fistula of the sigmoid is to provide for a gas vent, which is obtained by placing a tube with a quarter of an inch lumen in the rectum; the tube may be larger or smaller, according to the case. The abdomen being open, the tube is passed into the bowel through the fistula from above before closing. The side of the tube is sutured to the fistula, allowing its end to extend two inches higher within the intestine; one or two extra openings are made in the tube. Slight traction on the tube from the anal exit helps in the application of purse-string or other forms of sutures to close the fistula. Larger tubes become quite painful as they pass through the anal ring. To relieve this condition and to insure an absence of gas tension, the sphincter ani may be split anteriorly with an electric or Paquelin cautery at the close of the operation. In the case of a vaginal fecal fistula, splitting the sphincter ani in this manner renders a tube unnecessary. This being done with the cautery, there is no infection, and granulation tissues soon protect the area. Vaseline is freely applied, and the contraction of the burn usually closes the muscles to perfect function. When the intestinal wall is much infiltrated around the area of the fistula, an appendicostomy, with a catheter inserted, has often been of great aid in delivering gases from the proximal side. After the second day, a small injection of water through this tube a couple of times a day is of advantage. Should a slight gas fistula be noted on the fifth day, the tube has probably been allowed to accumulate fecal matter. In cases of primary and unexpected fistulas which are passing gases and liquid fæces, if the nurse will see that the rectum is kept emptied a considerable percentage of such fistulas will close without other operation. The dry, hard material accumulates and cakes in the rectum and will not be found without digital examination.

OBSERVATIONS ON THE TREATMENT OF DIRECT INGUINAL HERNIA IN ADULTS*

By LUCIUS W. HOTCHKISS, M.D.

OF NEW YORK

FROM a considerable experience with the surgery of direct inguinal hernia in adults, as well as from numerous observations made upon cases of recurrent hernia submitted to reoperation, I have been forced to the conclusion that the typical Bassini operation, while perhaps the most valuable single procedure that we have for the repair of the indirect inguinal hernias, does not begin to fulfil the indications which are constantly met with in the repair of these very troublesome cases of direct and potentially direct inguinal hernia which are constantly met with in middle-aged and elderly men. I have been astonished, indeed, at the rather large proportion of these cases in hospital practice. They are sometimes small, sometimes of large size and many of them are incomplete and difficult to support with a truss. They furnish a most interesting and ever-present problem to the surgeon, and a not inconsiderable number of recurrences to the patient. It is a well-known fact that most recurrent hernias seldom return to the original operator for repair, and unless one has had some experience in repairing the recurrences of some of his more skilful colleagues, it is easy enough to fall into error as to the stability of his own results.

It may be well to admit, perhaps, that there is a small proportion of cases of direct inguinal hernia in men who are engaged in hard manual labor and whose tissues are relaxed and worn by toil, age and sometimes alcohol, in whom the repair is exceedingly difficult and even impossible unless the habits of life are changed or the character of the work altered. The number of such cases, however, will grow steadily less as we learn to eliminate all possible causes of failure which are not directly chargeable to the inherent difficulties of the case itself. It seems to be very difficult to follow up most of our postoperative hernia results in city hospital practice for much more than one year. Cases which have been classed as cured at one hospital have a most distressing way of turning up at some other institution as recurrences, and to one like myself who has had the privilege of serving at two hospitals in separate sections of the city, serving both ends of the line, as it were, there has come a rare opportunity of studying the results of others and at the same time furnishing me much food for thought as to who was taking care of my own failures. Thus many cherished illusions have vanished and a sharp stimulus has been furnished toward improvement in my own work. For a number of years at Bellevue Hospital I chose to operate upon such recurrent cases of hernia as came to my wards. These cases were not chosen

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DIRECT INGUINAL HERNIA IN ADULTS

because they were easy or because I liked to do them, but because I fancied they might furnish me some needed lesson. As a result of this work I found it necessary to modify my views as to the cause of postoperative recurrence of hernias. In the first place it was found that infection played a much smaller rôle in the causation of recurrence than I had supposed.

Secondly, a very large number of the recurrent cases indeed were not recurrences at all in the strict sense of the word but rather a failure of the primary operation to wholly repair the original defect. Allowing for the occasional case where perhaps no radical cure could be expected, by reason of tissue defects, it seemed a fair assumption, from my own experience, at least, that many of the operations which are done for the radical relief of direct inguinal hernia are often rather carelessly done and that not infrequently the mistake is made of trying to make some one operation fit all the cases rather than in trying to repair the breach by the method that seemed most appropriate to it.

Before passing through this somewhat chastening experience, it had seemed to me that the harmless necessary hernia which, like the poor, we have always with us, could, as a rule, easily be cured by a routine operation which could soon be mastered and often handed over to the intern with perfect safety. This I imagine has been quite a common feeling with most of us, but the war, the workman's compensation act, and the general tendency toward improved results and the general efficiency of surgical methods, have all tended toward more careful work and a closer study of the common every-day problems of surgery.

In operating upon recurrent inguinal hernias it soon became apparent that many inguinal hernias have two more or less well-defined sacs, viz., an indirect, which presents in the usual situation, and a smaller direct bulge to the inner side of the deep epigastric vessels, which has to be carefully looked for. Under such conditions, the indirect sac is readily seen, and dealt with, and the inguinal canal closed, *secundum artem*, but the potential or direct sac is often overlooked and later presents itself in the shape of a direct recurrent inguinal hernia which had actually existed as a small potential hernia at the time of the original operation. This direct sac presents itself at the second operation for the so-called recurrence, at the lower end of the repaired inguinal canal, and in most cases can be quite satisfactorily repaired.

The same rule obtains in many primary adult inguinal hernias, and a systematic exposure of the whole neck of the hernial sac often shows a well-defined direct hernia coextensive with an indirect hernia of which the sac may be large and descend into the scrotum. It is apparent then that if the one is repaired and the other ignored or overlooked there will be a return of the hernia sooner or later, and while the result may be classed as a recurrence, it is really a failure to fully repair the hernia at the first operation. In short, in overlooking the possible direct sac, we unconsciously

transgress against the first great law of hernial repair, viz., the tying off of the *whole neck* of the hernial sac as flush as possible with parietal peritoneum.

The repair of direct inguinal hernia is sometimes easy and sometimes very difficult. Much depends upon the extent of the breach, the character of the tissues, and the availability of some adjacent aponeurosis to supply the defect in the badly overstretched transversalis fascia. In many cases the bulging of the weakened transversalis fascia to the inner side and behind the deep epigastric vessels, together with the almost complete disappearance of the so-called conjoined tendon, which is relied upon in the Bassini technic, makes it imperative for the surgeon to supply if possible some tissue which will stiffen up the posterior wall of the inguinal canal and supply the place of the weak overstretched fascia transversalis.

The method of repair which has been followed in these cases is as follows: Through a generous incision the inguinal canal is opened and the character and extent of the hernia definitely determined. An effort is made to define the whole extent of the hernial sac, if there is a double sac, as is often the case, the indirect sac is separated from the cord, the deep epigastric vessels are divided between ligatures, and pushed aside, and the sacs opened. If it is found feasible to close the whole broad neck of the sac with a transfixion ligature this is applied. If, as is often the case, the neck of the sac is too broad and there is a sliding hernia of the bladder, the neck of the sac has to be snugly closed by a pursestring suture. After dealing with the neck of the sac, the deficiency of the weak transversalis fascia is supplied by the utilization of the anterior sheath of the rectus muscle in the following manner. The thick aponeurosis of the anterior rectal sheath is thoroughly exposed by retraction and a long incision is made through it to the muscle beneath. Sometimes a triangular flap with the base upward is fashioned and turned back from the underlying muscle. This broad flap of strong aponeurosis is then carefully stitched by its outer edge to the whole length of Poupart's ligament from the spine of the pubes outward as far as necessary. The interrupted suture of chromicized catgut is applied at rather close intervals so as to snugly fortify the breach caused by the deficiency of the weakened transversalis fascia. This it does very well and forms a firm, strong wall for the posterior boundary of the inguinal canal. In cases where there is great relaxation of the external oblique aponeurosis, the principle of the overlap is further utilized and the layers are broadly imbricated. The cord is led outside of the fascia and rests in the subcutaneous fat.

Such a repair is effectual and lasting and has been used for a number of years with increasing confidence.

I regret that it is impossible for me to furnish reliable statistics as to its efficiency, but as this is not a statistical paper and as the principles utilized show nothing new or original, but show merely an attempt to utilize that which is tried and based on solid foundations, it is offered as a small contribution toward the effective treatment of a common and rather difficult surgical condition.

LIGATION OF THE ABDOMINAL AORTA: LIGATION OF THE FIRST PORTION OF THE LEFT SUBCLAVIAN*

BY CARL A. HAMANN, M.D.

OF CLEVELAND, OHIO

THE purpose of this communication is to record a case of ligation of the abdominal aorta and one of the first portion of the left subclavian artery, together with brief comments on the same.

CASE I.—Ligation of the abdominal aorta, just above its bifurcation, for a pelvic tumor, mistaken for an aneurism; survival of patient for six months without gangrene of the extremities. Death due to hemorrhage from a bed sore.

Mr. J. B., aged fifty-one years, entered the City Hospital, Cleveland, on March 28, 1916, complaining of pains in the lower extremities, partial paralysis, and loss of control of bladder and rectum.

There are no facts in his family or personal history that bear upon his present illness, which began between five and six years ago, with pain in the calf muscles of his right leg, subsequently involving the toes and region of the hip. Various forms of treatment were resorted to without benefit. His right lower extremity became useless. In May, 1915, the right great sciatic nerve was stretched; no improvement resulted. Later his left leg became painful and partially paralyzed, and he was confined to bed after September, 1915. Subsequently incontinence of urine and feces developed. About this time the Wassermann reaction (blood and cerebrospinal fluid) gave negative results.

Physical Examination.—Patient was a poorly-nourished man, whose general appearance was indicative of long-continued suffering. There was a large pulsating mass, occupying the pelvis. The right gluteal region was prominent and there seemed to be distinct, eccentric pulsation. Upon rectal examination the mass was readily felt; it was tender and pulsated strongly. A "to-and-fro murmur," as it was called by the recorder, was heard over the mass. The lower extremities were atrophied; there was paralysis of the extensor muscles of the right foot. The lower part of the abdominal wall was hyperæsthetic; the buttocks, scrotum, and part of the right lower extremity were anæsthetic. The knee-jerks were exaggerated. There was incontinence of urine and feces.

It was obvious that the pelvic tumor was the cause of the symptoms, and the question as to the nature of the tumor was an interesting one. Various examiners called it a sarcoma, others an aneurism. It seemed to me to be an aneurism, and, as it apparently involved the right internal iliac or its branches, I advised ligation of this vessel, which was done on April 4, 1916. When the abdomen was opened the internal iliac at and near its origin was found to be normal, and as it was believed that

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its branches were involved the vessel was tied with chromicized catgut. Pulsation in the tumor ceased for some days only, and the patient was not relieved.

By September, 1917, the pulsating mass had increased in size, and could be felt on the left side. Ligation of the aorta was proposed to the patient and he acquiesced.

On September 11, 1917, the aorta was tied with heavy braided silk, about one-half inch above the bifurcation. The ligature was tied so firmly as to divide the intima and media, as nearly as could be determined. The coats of the vessel seemed normal. The pulsation in the pelvic mass at once ceased and never returned. The lower extremities were wrapped in cotton to maintain warmth. Seven hours after operation patient complained of burning pain in the limbs, subsequently there were not observed any motor or sensory phenomena of consequence. There was no disturbance of the renal function. On the third day after operation, a faint pulsation could be detected in both femoral arteries. There never was any evidence of gangrene of the toes, except that, as the result of a burn from a hot water bag, the distal phalanx of one great toe became necrotic and after separation the stump healed over. On the whole there was considerably less pain in the extremities after the operation and he was able to move them better. Over the sacro-iliac region, posteriorly, there gradually appeared pulsating vessels, evidently a part of the collateral circulation. Pressure sores appeared on the heels, and a previous bedsore became gradually deeper. One leg was amputated in the lower third, with a view to relieve him of the heel pain; the wound never united. He began to bleed from the bedsore and died on March 13, 1918, six months after the ligation of the aorta, following a rather severe hemorrhage from the bedsore.

Autopsy.—The pelvis was filled with a large, solid tumor 5 or 6 inches in diameter; there were metastases in the liver. Histologically the growth was found by Dr. Howard T. Karsner to be a carcinoma, in which the tissue resembled the structure of the thyroid gland. (There had not been observed any enlargement of the thyroid and the gland was not examined at the autopsy.) The diagnosis of aneurism had therefore been wrong. The aorta was constricted by the ligature which was still in place, and imbedded, but was not obliterated, there being an opening less than $\frac{3}{16}$ of an inch in diameter; the vessel was normal in calibre above the ligature, as were also the common iliacs. The lumen of the right internal iliac had also been partially restored.

The main points of interest in the above case would seem to be the following: First, the fact that the patient lived six months after ligation of the abdominal aorta just above the bifurcation, without the appearance of gangrene of the extremities.

Second, the partial restoration of the lumen of the vessel, after apparent complete obliteration by a firmly tied silk ligature.

Third, the reappearance of the femoral pulse on the third day.

Inasmuch as the aorta was not found to be completely obliterated, in this case, it can hardly be said that proof is afforded that collateral circulation can

LIGATION OF THE ABDOMINAL AORTA

develop after ligation of the aorta to a sufficient extent to prevent gangrene. In both Keen's and Tillaux's cases, which lived respectively forty-eight and thirty-nine days, there was found a lumen at the seat of ligation, so that these cannot, in my opinion, be adduced as proof that collateral circulation can develop sufficiently after complete and permanent obliteration of the lumen of the aorta; furthermore, the complete obliteration of the lumen would probably sooner or later result in cutting through of the ligature and death from secondary hemorrhage.

The reason for the incomplete obliteration of the lumen of arteries by ligation is to be sought, in the majority of instances, in the slipping of the first turn of the knot, before the second one is tied, as Ballance and Edmunds point out.

It is my belief that ligation of the aorta below the origin of the inferior mesenteric is a justifiable procedure in cases of iliac aneurism, for instance, and that it affords fair chances for recovery and cure.

The abdominal aorta has been ligated sixteen times, as near as I have been able to learn. Most of the patients died soon after the operation. Tillaux's patient lived thirty-nine days, Keen's patient forty-eight days, and the one above recorded six months. Guinard reports a case of ligation of the thoracic aorta distal to an aneurism of the arch; the patient died of anuria, as is to be expected if the ligature is applied above the renal arteries.

LIGATION OF THE FIRST PART OF THE LEFT SUBCLAVIAN ARTERY

E. R., aged fifty years, had an aneurism about 1 inch in diameter, involving the third portion of the left subclavian artery, which had been noticed for about one year; there were no marked evidences of pressure on the vein or nerves, though he had some pain. Wassermann reaction negative. There was a moderate degree of arteriosclerosis and the arch of the aorta was somewhat dilated.

He was operated upon at Charity Hospital May 10, 1917.

The third portion of the artery was exposed by the usual incision, and it was found that the dilatation extended beneath the scalenus anticus; this muscle was therefore divided after displacing the phrenic nerve. The subclavian and internal jugular veins and thoracic duct and vagus nerve were held aside and the first portion of the artery well exposed; it was somewhat dilated. A double ligature of braided silk was passed around the vessel and firmly tied. Pulsation in the sac ceased at once and did not return.

The wound healed *per primam* and no disturbances in the circulation of the upper extremity, except for the absence of the pulse beyond the ligature, ever appeared. The sac contracted into a small firm mass and when last seen, four or five months afterwards, the patient was quite well.

In this case the branches of the subclavian were not tied, as has been suggested and practised by a number of surgeons, in order to lessen the dangers of secondary hemorrhage.

CARL A. HAMANN

The literature of ligation of the subclavian has been reviewed and statistics collected by a number of writers, references to whose articles are given below.

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THE USE OF THE PEDUNCULATED FLAP IN RECONSTRUCTIVE SURGERY*

BY JOHN STAIGE DAVIS, M.D., CAPTAIN M. R. C.

OF BALTIMORE, MD.

IN this war there have been many whose wounds have caused the loss of skin and subcutaneous tissue, and even deeper tissues, in situations which ultimately will require a resistant, elastic healing, before a satisfactory functional result can be obtained. Many of these defects can be properly remedied only by the use of pedunculated flaps of skin and subcutaneous tissue. Some of us will see these cases abroad, and others will be called upon to treat them if they are sent home. For this reason it seemed worth while at this time to consider this subject with which, perhaps, you are all more or less familiar.

A brief review of the development of the use of pedunculated flaps may be of interest.

The history of pedunculated flaps is closely associated with the development of rhinoplastic operations, and nearly all of the procedures used were originally employed in the process of this development. Long years before plastic surgery was attempted in Europe, certain individuals of the Tile maker caste in India obtained wonderful results in plastic operations with pedunculated flaps from the cheek and later from the forehead, in the repair of amputated noses. This is known as the *Indian method*.

It is interesting to note that plastic surgery was practised in India and Egypt, as has been shown by the sacred writings of India, and in Ebers' Papyrus, in both of which rhinoplasty is mentioned as a well-known procedure.

Celsus speaks of the restoration of ears, noses and lips by the aid of the neighboring skin, and Galen, Antyllus and Paul of Aegina, also mention these operations. Then for many years the art of plastic surgery seems to have been lost, at any rate to European surgeons.

In the middle of the Fifteenth Century, about 1442, Branca, or Brancas, a Sicilian surgeon, was able to build noses by pedunculated flaps from the skin of the face, and following him his son Antonius is said to have restored a lost nose by means of a flap from the arm. The first report of the use of the arm flap in medical literature is a brief note which is found in a work on anatomy by Alexander Benedictus, published in Venice in 1497.

Other surgeons of more or less repute were impressed with this work, and various allusions to the operation are to be found in surgical writings of the Sixteenth Century.

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JOHN STAIGE DAVIS

The work of Gaspar Tagliacozzi (1546-1599), published in 1597, was the first systematic treatise on plastic surgery. In it he described several operations, but gave special prominence to his method of rhinoplasty, in which he used a pedunculated flap from the arm. Two parallel incisions about 20 cm. long and 10 cm. apart were made down to the fascia on the anterior aspect of the left arm. The flap was separated from the fascia and was kept away from its bed by oiled linen, but the pedicles at each end were not divided. After a fortnight, when granulation and thickening had occurred, the upper pedicle was cut, and the flap was sutured into the defect after revivification of the edges. The arm was held in position by a special harness and after three weeks the other pedicle was amputated from the arm, and the flap was shaped and fitted into the desired position. This is called the *Tagliacotian* or *Italian method*.

The pupils of Tagliacozzi continued to carry out his method, but within a few years the method was lost sight of, and in course of time began to be considered impossible.

Reneaulme de la Garanne, in 1712, tried to rehabilitate the method, and proposed sewing into the defect the fresh flap immediately after raising it, without waiting for it to granulate. However, the art remained lost to practical surgery until 1816, when v. Graefe again revived the method and reported one successful case. He modified the method by cutting the upper pedicle at once, and by sewing the fresh flap into its place without waiting for it to granulate, thus making of it a single operation.

J. C. Carpue, of London, was the first surgeon who successfully performed rhinoplasty by the Indian method, and reported two successful cases in 1814 and 1815. Since that time the operation has been performed many times and numerous modifications have been made in the original method. The use of the pedunculated flap of skin and subcutaneous fat, based either on the Indian or the Italian method, and applied fresh or granulating, gradually became more common, especially for the relief of contractures, and in locations exposed to pressure and friction. The transplantation of pedunculated flaps by successive migration was probably first employed by Ph.-J. Roux in supplying lost portions of the cheeks: the flap was first taken from the thigh of the patient (Pancoast). Blandin reported a case where a part of the upper lip and a part of the cheek and ala of the nose had been destroyed. He raised a flap from the lower lip and attached it to the upper lip, then transferred it successfully to the cheek and nose.

The first report of the use of a pedunculated flap from adjacent tissue by an American surgeon is that of J. Mason Warren, of Boston, in 1837. He was successful in constructing a nose by the Indian method with a pedunculated flap from the forehead. T. D. Mütter, of Philadelphia, in 1842, reported three cases in which he successfully shifted large pedunculated flaps of skin and subcutaneous fat from the shoulder and deltoid region, to fill defects left by relieving contractures of the neck and chin following burns. Joseph Pancoast, of Philadelphia, in 1842, reported the successful use of

THE USE OF THE PEDUNCULATED FLAP

pedunculated flaps from the cheeks, forehead and upper lip. Frank H. Hamilton, on January 21, 1854, in the Buffalo General Hospital, raised a whole thickness pedunculated flap 4 x 7 inches, from the calf of a man's leg for the relief of a large traumatic ulcer of the other leg. This flap was held away from its bed by dressings, and remained viable, although there was considerable shrinkage. After two weeks he freshened the under surface and edges of the flap, excised the ulcer and part of the cicatrix, then partly covered the wound with the flap and secured the legs together. Two weeks later the flap was amputated from its base, and a portion of it subsequently sloughed.

After this there were reports on the subject from the United States, England, France and Germany, but it was not until the work of Maas, 1884-1886, that widespread attention was given to the use of pedunculated flaps. His papers were so convincing that new impetus was given to the method. Since his death there has been much work done on the subject by many surgeons, and splendid results have been reported.

The original Indian and Italian methods have been modified from time to time, but the basic principles of these methods are unchanged.

By a pedunculated flap I mean a mass of tissue, usually the skin and subcutaneous fat, which is raised from its bed, but is left attached to the surrounding skin at a selected portion of its margin. There is another type of pedunculated flap with a pedicle of subcutaneous tissue, the skin being cut all around it. It was first used by Gersuny, and is useful in closing defects in the mucous membrane. Esser has recently described similar flaps, calling them "island flaps." Through this skin or subcutaneous attachment, called the pedicle, the flap receives its blood supply. The flap can be shifted as far as its pedicle will permit, to fill the defect.

Pedunculated flaps may be obtained from tissue in the neighborhood of the defect, or from a distant part. There may be a single or a double pedicle. There are three general methods of obtaining pedunculated flaps:

First, *the Indian method*, in which the flap is obtained from the immediate neighborhood of the defect, and is shifted into its new position by more or less twisting of the pedicle. The pedicle of the flap may be adjacent to the defect, or it may be necessary for the pedicle to bridge over normal tissue before the flap can be placed in its new position.

Second, *the Italian, or Tagliacotian method*, in which the flap is obtained from a distant part, usually from the arm.

Third, *the French method*, of sliding flaps from adjacent tissue, in which process there is little or no torsion of the pedicle.

A way of further utilizing pedunculated flaps was described by Dr. W. S. Halsted in 1896. He reported a method which he had used in the treatment of an extensive burn of the cheek, neck and arms, and he spoke of the method as "waltzing" the flap. He says, "None of the original attachments of the last flap which we used have been preserved. The flap has twice been twisted upon itself, first upon a small pedicle of skin, original tissue we may call it,

and, secondly, upon a little broader pedicle of cultivated cicatricial tissue. The flap has probably made a complete revolution." In my own work I have found this a most useful method and by this means it is possible to gradually shift masses of skin and subcutaneous fat into positions far removed beyond the restriction of the original pedicle.

The transfer of the flap may be *single*, that is when it is placed directly on the defect. This may be done whether the flap is from the neighborhood or from a distant part, and either immediately after cutting (fresh) or after granulations have formed.

The transfer may be *multiple*, or by *successive migration*, that is, where it is impossible on account of its position to place the flap directly on the defect. For instance, in cases where it is advisable to use a flap from the abdominal wall to repair a chin, the flap is raised and grown into an incision in the forearm or hand. Then, after the circulation is established from the forearm, the pedicle is amputated from the abdomen and the flap is transferred on the forearm to the chin. In due time the flap is cut away from the forearm and is immediately fitted into its new bed. This method has also been used from abdomen to chest, to neck, to chin, and in other combinations. In this process of gradual transfer the raw surface of the flap necessarily granulates, and the shrinkage is considerable.

If an abdominal flap be used with a pedicle on one side of the midline, it is advisable, on account of arterial distribution, that the skin of the flap should be taken from the same side. This is unnecessary where the pedicle includes skin on both sides of the midline.

The area from which the pedunculated flap is taken may be closed by suture if the skin is lax, or after undercutting and sliding. If closure is not possible on account of the size of the area, then it may be covered with skin grafts, preferably of the Ollier-Thiersch variety.

Pedunculated flaps may be *simple*, where only the skin and subcutaneous tissue is used, or *compound*, where periosteum, bone or cartilage is included in the flap.

In *compound* flaps the periosteum or bone may be taken up with the flap without being separated from the soft parts, as when periosteum and bone are raised from the frontal bone in certain rhinoplastic operations, or when a portion of the clavicle is raised with a flap from the neck to repair a jaw defect.

When cartilage is used, a shaped section of cartilaginous rib is ordinarily transplanted to the desired location in the future flap, and after it has become established in its new position, from three to six weeks, the flap containing the cartilage is raised and shifted to the defect. The method is also employed when it is desirable to use free bone or free periosteum in a flap.

Double-faced Flaps.—If a pedunculated flap of any considerable size is used to construct a lip or eyelid, or to fill a defect inside the mouth, an epithelial and not a raw surface should be placed inside the cavity. Unless this is done contracture will take place, as the mucous membrane does not spread

THE USE OF THE PEDUNCULATED FLAP

with sufficient rapidity to cover the raw surface in time to prevent contracture.

In some instances, for example, where the reconstruction of the lower lip is contemplated, it is necessary to have a flap which is covered with epithelium on both sides. This may be accomplished by grafting the under surface of the flap and waiting until the healing is complete before transferring the flap, as is well described by Watts. Another method which I prefer is folding the end of the flap on itself and allowing the raw surfaces to heal together. Then transfer in the usual way. If a supporting substance is necessary in such a flap, free cartilage may be inserted between the raw surfaces.

Lefevre says that Chavannaz had good results in two cases by turning the raw surface of a pedunculated flap inside in cheek plastics. Lefevre did some experimental work on dogs to prove the point, and says that the results were very satisfactory, and that the raw surface healed in from sixteen to thirty days.

My own experience leads me to believe that only flaps covered with epithelium will prevent subsequent contractures when turned inside the mouth.

The attachment of one person to a pedunculated flap raised from another (which may be called symbiotic transplantation) has been attempted a number of times, but without very satisfactory results. Finney reported an unsuccessful case of this kind before this Association on June 5, 1909, and quoted Lund, who had had little better success in his own case. In both of these cases there were unavoidable complications which tended to cause failure. The method is even more trying on the participants than when autoplasty is practised by pedunculated flaps from distant parts, and for this reason is not to be recommended. However, there is no reason why such a procedure should not be successful under favorable conditions.

O. Laurent reported four cases in which he successfully used pedunculated flaps from other persons for the repair of extensive humerus or femur defects. The donors and recipients were fastened together from eight to ten days. Excess bone in amputation stumps, which required shortening, was used in each case, and the results were said to be satisfactory.

In using pedunculated flaps the following are some points which experience has shown to be essential for success.

The patient should be in the best possible physical condition. Asepsis rather than antisepsis should be maintained throughout the operation and during convalescence. The tissues should be treated with the greatest consideration. Keen cutting instruments must be used to avoid unnecessary injury to the tissues. The flaps should be handled with special forceps, or small sharp hooks. All hemorrhage should be checked in the area into which the flap is to be transferred. Accurate apposition of the sutured edges is desirable, as prompt healing minimizes scar tissue. The sutures should be placed so as to avoid tension, which always jeopardizes the success of the flap.

Pedunculated flaps are especially valuable when a pad of fat is required to fill a defect in addition to the whole thickness of the skin. Flaps usually include the skin and as much of the subcutaneous fat as is needed. The fat

should be somewhat thicker than is actually necessary to fill the defect, as the excess is taken care of by subsequent shrinkage.

The shape of the flap must correspond fairly accurately to the defect which it is to cover. Long pointed flaps should be avoided, on account of almost certain necrosis of the tip. Thin flaps are so pliable that they can be easily adjusted to fit a defect of almost any shape, but especially in rhinoplastic operations it is desirable to outline the flap from a carefully calculated pattern. The skin of pedunculated flaps must be chosen with some regard to the character of the skin surrounding the area into which it is to be placed. That from the immediate neighborhood usually matches better than that from distant parts.

A flap of hairy skin should never be turned into the mouth, or any other mucous lined cavity, as the hair will continue to grow and will give much discomfort. This has also been the rule about shifting flaps of hairy scalp to fill defects on hairless portions of the face. Recently P. P. Cole reported that he used hairy scalp to repair a face defect, and that subsequently by radiation the hair was readily removed, leaving a smooth skin.

The flap should be cut about one-third larger than the area it is to fill, as there is always immediate shrinkage which is in the direction of the elastic fibres. Normal skin is necessary for a successful flap, as any scar on the edge of a flap will usually slough, and a scar running across a flap will completely cut off the circulation beyond it. If possible, always excise all scar tissue, especially along the edges to be sutured, as the healing will be more satisfactory if normal tissues are approximated.

The pedicle should be as broad as possible, but in all flaps which are to be twisted, it should be narrower than the body of the flap. In flaps from the immediate neighborhood always aim to have the pedicle very close to the loss of substance, and when practicable the long axis of the pedicle should be in the same direction as the axis of the flap in its new direction. The pedicle of a flap should be in the same line as the area to be filled. The elasticity of the skin will allow a curved flap to assume a straight position without difficulty.

As a general rule the flap should never be longer than two and one-half to three times the width of the pedicle, unless it contains a main artery, in which case the pedicle may be much less wide and the flap less thick. However, a main artery is not essential if the pedicle is adequate and the flap is thick, and includes small vessels for its proper nutrition.

If the pedicle of a flap adjacent to the defect is too short to allow turning into the defect without tension, the incision not terminating in the defect should be prolonged outward.

A pedicle should never be notched at time of implantation to make it fit better, as the circulation might be impaired. If there is puckering of the edges of a pedicle it can be adjusted after the new circulation is assured. Twisting or too much tension on a pedicle may cause shutting off of circulation, and gangrene of the flap.

THE USE OF THE PEDUNCULATED FLAP

There is sometimes gangrene of a flap which has an excellent blood supply due to lack of drainage from the flap. In other words, the flap is choked by blood and lymph entering it and being unable to get out promptly. This is especially to be feared if the pedicle contains a main artery. To overcome this danger C. H. Mayo suggested superficial scarification of the flap to allow surface drainage until proper vessel drainage is established, and I have found the results satisfactory. When a long narrow flap is required and there is doubt about the blood supply, it is advisable to raise it from its bed, but to leave it attached at each end after the method advised by Croft, although this is what Tagliacozzi did in his original operation. If this is done close the skin beneath the flap if possible, or keep it separated from its bed by rubber tissue, or graft the bed beneath the flap with Ollier-Thiersch grafts. After two or three weeks cut one pedicle, then freshen the granulating surface, and transfer the flap in the usual manner, subsequently severing the other pedicle.

I usually wait from ten days to two weeks before amputating the pedicle of a flap. Some have advised amputation as early as the fourth day, others insist that three weeks should elapse before severing the pedicle. The circulation of the flap may be tested before cutting the pedicle by applying a stomach clamp across the pedicle, tight enough to shut off the circulation, but not sufficiently tight to damage the tissue. The amputation may be done by notching one or both sides of the pedicle, thus gradually cutting off the circulation, or it may be done at one time. After the pedicle is cut through, the end of the flap towards the pedicle should be fitted to its proper place at once, and if possible the stump of the pedicle should be returned to its original bed, as in this way a better result can be obtained with little, if any, loss of tissue.

Flaps of normal tissue are often successfully shifted into the midst of scar tissue, as in the popliteal and cubital spaces, but the circulation of these flaps should be especially good.

Immobilization of the part with plaster of Paris, crinoline or splint is essential, and the dressing next to the transplanted area should be soft and very carefully and evenly applied. My own preference is for the use of compresses wet with normal salt solution for the first forty-eight hours. In shifting double pedicled flaps on the neck or from the neck to the chin or lip, it is advisable to provide for drainage with a small protective wick in each lower angle.

The use of strong antiseptics should be avoided. I prefer horsehair for skin sutures, and use a half-curved corneal needle, which penetrates the skin easily. Catgut is advisable for buried sutures and ligatures in plastic surgery.

The flap should be inspected frequently, as the evacuation of a collection of serum, the combating of a slight infection, or the loosening of tight stitches may change into a success what might otherwise be a failure.

Occasionally it may be necessary within the first forty-eight hours to shift

the flap back to its original position, when its death seems imminent for one reason or another.

Skin flaps may be turned into the mouth to take the place of destroyed mucous membrane. Flaps may also be inserted by tunnelling under normal tissue. This may be done with the ordinary pedunculated skin flaps or with island flaps.

Double pedicled "gauntlet" flaps raised from the chest, abdominal wall, back, or thigh, are often used for the repair of lesions involving the hand or fingers. The flap is raised and the part is slipped beneath it, and is immobilized. After the blood supply is assured the pedicles are cut, either both at one time, or separately, and the edges of the flap are sutured into position.

The transplantation of flaps whose pedicle consists only of the temporal artery, veins, etc., was reported by Monks in 1898. He constructed a new under lid by using a crescentic-shaped flap of the skin of the forehead, into which the anterior temporal artery ran. He then dissected out the artery and accompanying veins, and after tunnelling passed the flap through and sutured it in position, thus leaving the vessel under the skin. Horsley, in 1915, suggested a similar procedure for repairing a cheek defect, not being aware of Monk's report. He did not use the tunnel method, but implanted his vessels in an incision which was closed over them. The principle was the same, although the size of the flap and the technic were different.

If by chance the nerve which supplies the portion of the skin which is used as a flap should pass through the pedicle, the sensation remains in the flap until the pedicle is cut. After that the sensation is cut off for the time being. After five or six weeks sensation begins to return by the nerve supply coming in from the periphery, as in whole-thickness skin grafts. The flaps regain tactile sensibility first, then pain, and finally temperature sense. If the flap is large the central portion may not regain its sensation for a considerable time.

In my last two rhinoplastic operations by the Indian method, the pedicle contained the left angular artery, and evidently an undisturbed nerve supply, as when the stitches were removed along the alæ and columna, both patients complained of pain high up on the forehead. This sensation was frequently tested and continued for several weeks, until the pedicle was cut, after which all sensation was temporarily eliminated.

Grafts of all types may become pigmented, but pigmentation seldom occurs in pedunculated flaps, and for this reason they are to be preferred for cosmetic reasons on the face and other exposed positions.

In addition to the use of the ordinary skin and subcutaneous fat flap, pedunculated flaps of other tissues may be used in reconstructive surgery.

Mucous Membrane.—Pedunculated flaps of mucous membrane may be used with satisfaction when available for filling in lip and cheek defects.

Fat.—Pedunculated flaps of fat are often used to fill defects in bone; to raise depressed scars; to surround tendons and nerves, and to prevent

THE USE OF THE PEDUNCULATED FLAP

adhesions. It is also used in joints, but the combined fat and fascia flap is superior in arthroplastic operations.

Muscle.—Pedunculated flaps of muscle are used to fill defects in bone, as after mastoid operations, and to fill out depressions, as for example, those caused by the destruction of the malar bone in war wounds.

Fascia.—Pedunculated flaps of fascia are often used with success to reinforce weakened tissues, as for instance in hernia operations.

A review of the literature shows that during the last one hundred years practically every portion of the surface of the body has been repaired by means of pedunculated flaps for the relief of defects, either congenital or acquired.

The pedunculated flap of skin with the required amount of fat is one of the most dependable methods at our command for the repair of tissue defects. It is especially useful in repairing defects opening into the mouth or nose, bladder or vagina. No other surgical procedure is so effective in accomplishing permanent elastic healing in areas exposed to constant trauma, as around joints, on the soles of the feet, etc., etc.

A pedunculated flap with good circulation will live and succeed in positions in which free transplants are contra-indicated. The neglect of this valuable surgical measure is quite general among surgeons, but its many advantages should assure its constant employment in suitable cases.

By the use of pedunculated flaps function may be restored, and cosmetic results be obtained in many cases otherwise beyond the help of surgical procedures.

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HEREDITARY OSTEOPSATHYROSIS*

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As the condition of hereditary osteopsathyrosis, or fragilitas ossium, is quite rare, it is felt that the publication of a single case is justified. The history of the patient who has on several occasions been under my care is as follows:

Mrs. S., a widow, aged forty-two, born in Ohio, entered the Gynecological Service of the University of California Hospital in October, 1912, for uterine fibroids. She was operated upon by Dr. W. G. Moore, a hysterectomy being done, and was then transferred to my service because of the many fractures she had sustained. The only thing of importance in her family history was that her father had had many fractures and blue sclerotics. He died at the age of fifty-one. Her mother died from accident at the age of twenty-six. One brother and one sister alive and well. The history of her grandparents could not be ascertained. Her paternal uncles and aunts were normal, so far as fractures were concerned. Patient had measles, mumps and whooping-cough in childhood and probable typhoid fever twelve years ago. One miscarriage, no children.

At the age of eight months, patient had a fracture of one tibia, and from that time to the present, she has had at least sixty other fractures, involving most of the long bones, as well as the pelvis and both patellæ. Fractures of the phalanges have occurred from merely shaking hands. Strangely enough, neither femur had been broken until her last admission in 1917, but frequent fractures of her leg bones interfered with her activity as a professional dancer. Patient seldom called in a surgeon for her fractures, but "set" them herself, and as a result there are numerous deformities. She has noticed that her fractures unite more rapidly than normal, some of them being quite solid in nine days. She was observed by us in May, 1915, when she had a fracture of the right ulna and the right patella. There were marked ecchymoses, but pain and tenderness were much less marked than in a normal individual, and disability was slight. Solid union of the ulna occurred in eighteen days and the callus was very small.

Physical examination showed marked prominence of the frontal bones; marked blueness of the scleræ, due probably to increased translucency, the color being transmitted from the choroid coats; almost complete deafness of left ear. Thorax somewhat deformed from fractures of the right clavicle and several ribs. No evidence of rickets. The lungs were normal; slight murmur at the apex of the heart; abdomen negative except for operation scar; spleen not palpated. Systolic blood-pressure 210, diastolic, 155. Hæmoglobin from 65 to 75 per cent.;

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red corpuscles 4,700,000; white corpuscles, 7400; neutrophils, 59 per cent., lymphocytes 35 per cent., large mononuclears 6 per cent., eosinophiles 0 per cent. The urine usually shows a faint trace of albumin with some pus-cells—no sugar—an occasional hyaline and granular cast. Several examinations showed no increase in earthy phosphates in the urine. The reflexes were normal and her musculature good, considering her sedentary life. The Wassermann reaction for lues was negative.

The patient is under normal height, but is not grossly deformed, except about the elbows, which show marked irregularity with limited flexion and extension, the result of repeated fractures, particularly of the lower ends of the humeri. There is no bending of the bones as in osteomalacia.

A number of röntgenograms were taken, some of which are here reproduced. They show a marked thinning of the bone cortex. In Fig. 1 there is to be noted a recent fracture of the right ulna.

When last admitted to the hospital in July, 1917, this patient had fractures of both legs—the tibiae and fibulae—and of the left femur. She stated that while walking to her door, her legs gave way and she fell to the floor and that the bones broke before the fall. Three months before she had sustained multiple fractures of the left tibia and a fracture of the left patella, but these fractures had united firmly before the last accident. Her last stay at the hospital was for five weeks when all the fractures were well united.

Lobstein, who in 1833 published the first case and introduced the word osteopsathyrosis, referred particularly to the hereditary, so-called idiopathic type of the disease, thus excluding those cases of abnormal bone fragility due to known causes, such as tumors, senility, neuropathies, rickets and inflammatory processes. Up to 1905 only seventy-nine cases could be found in the literature by Doering and since that time about forty others have been reported.

The etiology is unknown, but we have reason to think that it is hereditary in most instances, although the published statistics show only 9.8 per cent. of the cases to be hereditary—lack of inquiry on the part of the physicians and lack of definite information regarding parents on the part of patients could easily make the statistics inaccurate.

The factor of heredity has been emphasized very strongly by Conrad and Davenport in a publication from the Eugenics Record Office on "Hereditary Fragility of Bone." They carefully studied the reported cases and arrived at the conclusion that "a parent who is, or was in early life, osteopsathyrotic, will have half of his children similarly affected no matter whom he marries; except that if the consort also be osteopsathyrotic it is to be expected that three-fourths of the children will be affected."

More recently Bronson has reported his interesting studies of two families in Scotland: "In the first family, consisting of fifty-five individuals in four generations, twenty-one had grey-blue sclerotics," and of the twenty-one, twenty had had fractures. "In the second family, consisting of eight

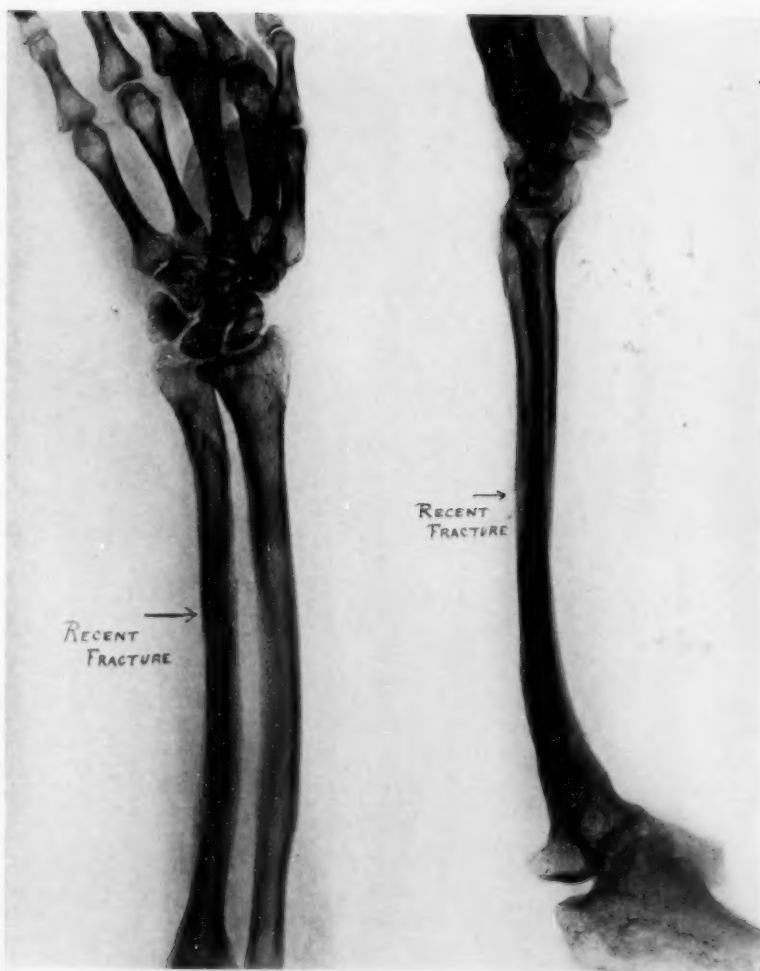


FIG. 1.—Right forearm, showing recent fracture of ulna.



FIG. 2.—Right leg, showing thin cortex.

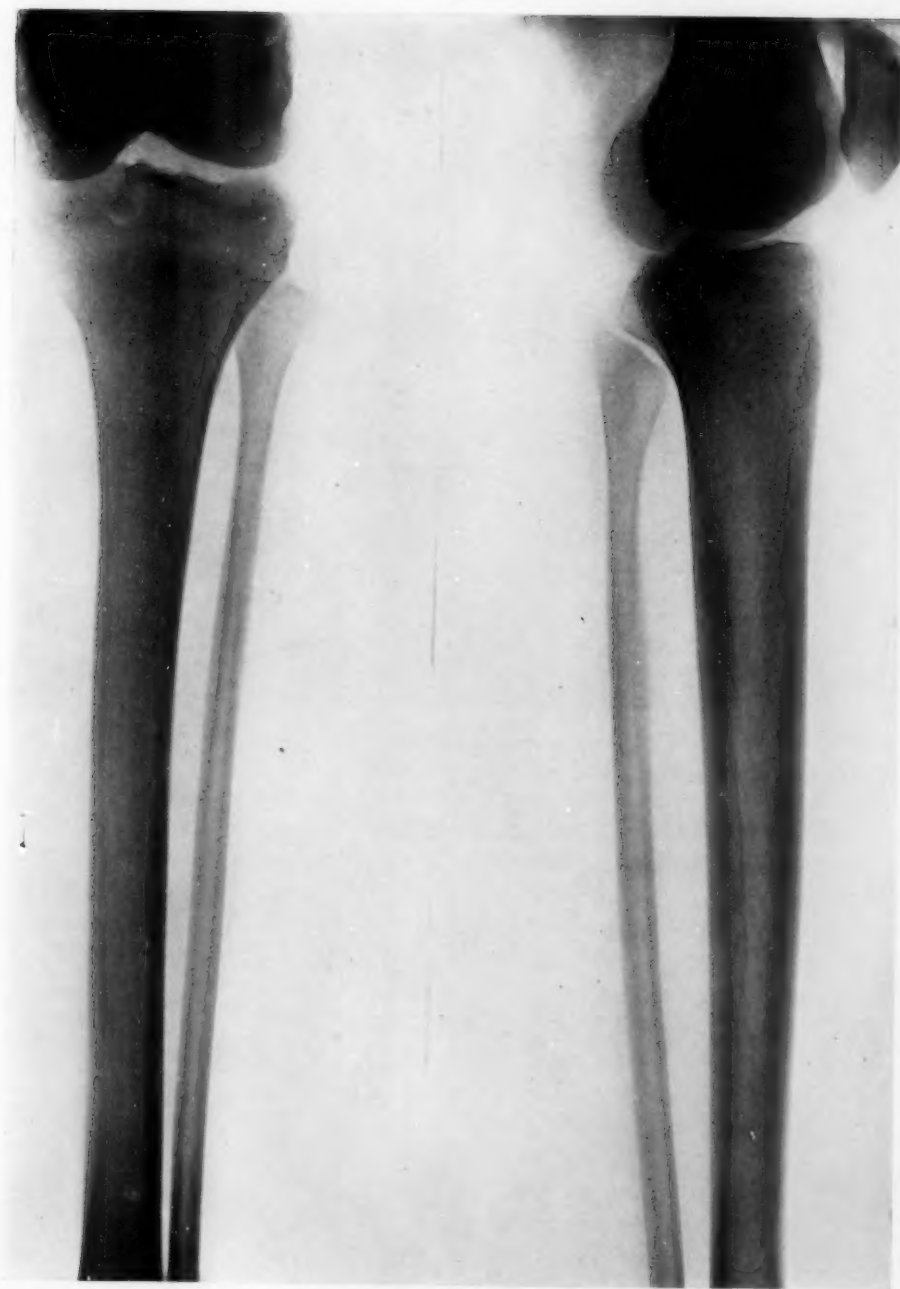


FIG. 3.—Normal bones of leg for comparison.



FIG. 4.—Elbow, showing result of repeated fractures.



FIG. 5.—Bones of hand.

HEREDITARY OSTEOPSATHYROSIS

individuals in three generations, seven have blue sclerotics, and four of these have had fractures; two others have a tendency to sprains." In 1900 Ed-dowes particularly noted the association of blue sclerotics and hereditary osteopsathyrosis and considered that they were always correlated.

We are better acquainted with the pathology of the disease than with the etiology. The bone cortex is thin and, as Lovett and Nichols have shown, the Haversian systems in the cortical substance are not formed, so that the cylinders of hard bone surrounding the Haversian canals are lacking, and the strength of the bone is thus impaired. Furthermore, there is a marked tendency in these cases for new bone to be formed by direct metaplasia of cartilage. This metaplasia would probably explain the clinically noted fact of the unusually rapid repair of fractures. I have not found any record of actual tests of the strength of osteopsathyrotic bones as compared with normal bones, but shall have such tests made should the opportunity ever present itself.

Nichols and also Looser consider osteopsathyrosis identical with osteogenesis imperfecta, yet clinically Emerson and others note that the fractures in the latter condition are found at birth, while with osteopsathyrosis the fractures may not occur for a number of years after birth. Furthermore, many of the cases of osteogenesis imperfecta are born dead and few if any survive any considerable number of years. It may be that osteopsathyrosis is simply osteogenesis imperfecta in a milder form.

Chemical examination of the bones in osteopsathyrosis does not give us any clue to the etiology—there is a normal proportion of organic and inorganic constituents. Furthermore, studies of the metabolism in these cases have not brought any definite result. In a very few cases there seemed to be an increased loss of calcium—in others the calcium metabolism was normal. Bookman reported from his studies on a case of supposed idiopathic osteopsathyrosis that there was a relatively enormous loss in calcium and a retention of sulphur and phosphorus. Unfortunately for these studies, the case can scarcely be considered one of osteopsathyrosis, as the radiographs showed multiple cysts in both humeri, the seats of the only two fractures which the patient had sustained. Syphilis quite certainly plays no part in the disease and has been definitely excluded in many of the recent cases. The Wassermann reaction was negative in the case here reported.

Speculation as to the possible rôle of the endocrine glands is proper, though as yet unprofitable. A considerable degree of bone fragility results from complete thyroidectomies, and changes in the bone occur after removal of the parathyroids. It has also been found that in thymectomized dogs there developed bone cysts and spontaneous fractures. Until, however, our knowledge of the glands of internal secretion is much more extensive, we shall not be able to connect them up with hereditary osteopsathyrosis.

Clinical Aspects.—It has long been noted that fractures in osteopsathyrotics usually heal very quickly with a minimal amount of callus forma-

tion—non-union is rarely seen in these cases, even where several fractures occur simultaneously. While pain is present, it is usually not so severe as in normal individuals, possibly because of lessened trauma. Pain preceding a fracture, as noted in cases of osteomalacia, is not present in osteopsathyrosis. The association of blue sclerotics with osteopsathyrosis occurs so frequently that we must consider them etiologically related.

No drugs have yet been found which influence the condition, and so far as treatment is concerned we are limited to treating the individual fractures conservatively and in accord with the best surgical principles of preservation of function and prevention of deformity.

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AMPUTATIONS OF THE LEG*

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How little we thought in 1914, when the International Society of Surgery met in New York City, that the world was soon to be plunged into a terrible war; yet Doctor Depage anticipated it, as indicated by his presidential address on war surgery. The large number of poor fellows who have returned from the front with mutilated bodies, many of whom will require amputations, or re-amputations, urges one to do everything possible for the future comfort of these men, and only those who have lost a leg appreciate the importance of having a good, useful stump. Many years ago Lister reported a patient with amputation of both legs who was able to dance the Highland fling. Subsequently, artificial limb-makers induced the surgeons to pay little or no attention to providing an end-bearing stump, as the socket of the limb took the weight of the body on its upper and inner surfaces. Fortunately, during the last few years, the importance of an end-bearing stump has been recognized. Everyone acknowledges the advantages of high division of the nerves, sawing the bones at right angle to the vertical axis of the body, and the accurate junction of the flaps; yet how often are these simple rules neglected. No operation has received less attention by the general surgeon than that of amputations.

A great advance was made when Bunge advocated the removal of a small portion of the periosteum and marrow from the ends of the divided bones. This prevented the formation of bony spikes which caused pain when pressure was brought on the end of the stump. The success which the aperiosteal method of treating the bone has given practically eliminates all other methods, with the exception of the Stokes-Gritti operation at the knee-joint. In this operation the condyles of femur and the posterior surface of the patella are removed with the saw. The patella is then placed on the end of the femur, so as to approximate the two sawn surfaces. A bony union takes place, and an excellent end-bearing stump is produced.

Amputations of the lower extremity should also be done by experienced surgeons and every detail carefully remembered, just as in breast or stomach operations. The flaps should be just long enough and trimmed so as to come together accurately with the junction behind the end of the stump. Excess of skin is almost as bad as too little, as it becomes folded and chafes when a sock is drawn on and a leg worn. The nerves should be divided high up so as not to become involved in the cicatrix. A neuroma in a stump gives most troublesome sensations and will usually require further operative work. Strip every vestige of periosteum a distance of one-quarter inch above the

* Read before the American Surgical Association, June 7, 1918.

point of division of the bone. Divide the bone at right angle to the vertical axis of the body and take off the sharp edges. Scoop out the medulla to a point corresponding to the division of the periosteum. If the amputation is below the knee, divide the fibula obliquely and at a little higher level than the tibia so that the stump may be more or less conical. Careful hæmostasis, a few strands of catgut for drainage, and horsehair for sutures complete the operation. Doctor Malloch, of Hamilton, a pupil of Lord Lister, always used No. 0 catgut for his ligatures, and he ligated the vessels only and not a mass of tissue as well. He eliminated dead spaces by sutures and used only small drains of catgut. His results were excellent, and I have endeavored to follow his teaching. Silkworm-gut should never be used to approximate the flaps, as their rigidity causes the patient pain when the dressing becomes shifted. This is a small point, yet, if acted upon, will prevent the patient having many a restless night.

The subsequent treatment of the stump is most important. Lyle, in this country, especially deserves credit for advocating the early massage and use of the stump in order to prevent atrophy of the muscles. It will take some time to teach limb-makers to refrain from giving instructions to their customers to bandage the stump in order to make it atrophy. A long stump of the leg, unless possessing a good end-bearing, will undoubtedly become objectionably cold when enclosed in an artificial leg. Many such have been re-amputated. Syme obtained excellent results with his amputation at the ankle, but the modern leg-makers objected to so long a stump, and the operation became unpopular. The longer the stump, the better control the patient has of an artificial limb, and the more pressure he can bear on the end of the stump, the less trouble he will have from callosities caused by the lateral bearings of the socket. If care be taken to encourage the patient to bear pressure on the end of the stump, he will be rewarded by being able to bear the whole weight of his body on it in a very short time. The daily massage, exercise, bathing and rubbing with alcohol will harden the skin and prepare the stump for a temporary leg. These exercises should not be started before the stump is healed. Pressure can then be made on the end of the stump by the nurse several times a day. Then the patient is encouraged to press the end of the stump against a padded box or chair. In a very short time he will be able to bear nearly the whole of the weight of his body on this stump. A temporary leg may then be used, as advised by Lyle, but I prefer to have a permanent leg fitted as soon as possible. The stump will shrink and the socket will require re-lining, but the patient will sooner learn a natural gait. In spite of all your care and instructions to the patient, you will usually find him fitted with a limb without an end-bearing block. This has been my experience, and hence the deduction that surgeons, as a rule, either do not know of the importance of an end-bearing stump, or else they do not take the trouble to enforce their instructions.

The subsequent welfare of the patient must always be remembered, and a very short stump below the knee will not swing a leg properly, no matter

AMPUTATIONS OF THE LEG

how good an end-bearing stump may be obtained. The end of the stump at its front part will become abraded by constant friction, caused by the attempt to swing the leg forward, for this cannot be done by the supporting band around the shoulder, hence a Stokes-Gritti operation through the condyles of the femur appears to me far preferable to the operation recommended by Felix Franks. The patella and the skin covering it has early become accustomed to bearing the weight of the body, and a good limb-maker can easily fit a limb where this amputation has been made.

Kineplastic amputations suggested by Vanghetti are, in my opinion, not applicable to the leg, as an end-bearing stump cannot be satisfactorily obtained. Too much stress cannot be laid on the advisability of a good end-bearing stump, and a good limb-maker can produce a foot with natural and useful motion, which will more than compensate for any supposed advantages of the kineplastic operation here.

One point more worthy of mention is that stumps that are too tender and cannot allow pressure on the end may, in the majority of cases, be educated to permit considerable pressure without causing discomfort. Where the skin of a stump is tender, especially marked in patients where amputation has been performed in the middle or later periods of life, a short stump sock made of angora wool, will give greater comfort to the patient than any other sock I have tried. The French wool is much superior to any made in this country, but, unfortunately, now it is almost impossible to obtain the French article.

RESULTS OBTAINABLE IN THE TREATMENT OF FRACTURES

REPORT OF THE COMMITTEE ON FRACTURES OF THE AMERICAN SURGICAL ASSOCIATION
PRESENTED JUNE 6, 1918

COMMITTEE:

W. L. ESTES, M.D., A. P. C. ASHHURST, M.D., EDWARD MARTIN, M.D.,
JOHN B. WALKER, M.D., and THOS. W. HUNTINGTON, M.D.

IN its preliminary report in 1915 it was stated by the Committee that it had set itself the task of trying to determine three points in regard to fractures of the long bones, namely:

1. To find out the average present-day results in both simple and compound fractures as regards anatomical and functional results in the several age groups, and the average time of disability. This latter period is determined to mean the average time the patient lost from work or from his ordinary duties.
2. The comparative value of (a) the conservative or closed methods; (b) the operative or open methods.
3. The comparative value of immediate or delayed treatment in each group of cases.

To carry out this plan it was necessary to obtain and to analyze a large number of well-kept and fully-registered fracture records. The Committee based its preliminary report on 1745 collected and investigated cases. The records of these cases, however, were so incomplete and unsatisfactory that for some of the points entirely too little data was obtained to form the basis for conclusions. In order to overcome this difficulty the Committee recommended to this Association a standard form for the record and preservation of fracture data, and requested that it be made the official form of the Association and that it be adopted by all fellows of this Association and by the hospitals with which they were connected. The Association adopted the form. It was also adopted by the Surgical Section of the American Medical Association, by several State Medical Societies, by the U. S. Army Medical Department, by the Compensation Board of Pennsylvania, and numerous hospitals and associations.

The Chairman sent out several thousand copies of these forms to the various associations, societies, departments, hospitals and individuals. The net result has been the reception of reports of 327 additional cases, up to date. Of these many were so incompletely filled out they were useless.

The Committee feels, therefore, that with so little additional data it can offer to the Association very little more towards the standardization of the treatment and the average time of disability of fractures of the several regions of the long bones in the several age periods than it did in the preliminary report.

RESULTS IN THE TREATMENT OF FRACTURES

The little additional evidence (all of which has been worked out, except a few cases left over by a Fellow who is in active military service) goes to confirm the conclusions of the preliminary report, namely:

The Committee finds:

1. The results are best in the age period under fifteen years. Conservative treatment is generally effectual during this period.
2. Good anatomical restitution of a fractured long bone always results in the best functional result, and has the shortest period of disability.
3. While few open operations are reported under the fifteen-year age period, it seems to make little difference in the result, except in senile cases (where it is unfavorable), what the age period is when the operation is done.
4. The end results of non-operative and operative treatment of compound fractures show very little difference in the anatomical result, but the functional results are better after operative treatment, except in compound fractures of the shafts of both bones of the leg; here the reverse seems to be true.

The age period except in senile cases has no marked effect on the result of the treatment.

5. The average period of disability (that is the time lost from work) in simple fractures, is as follows:

| | |
|--|-------------|
| For fracture of the shaft of the humerus..... | 14.0 weeks. |
| For fracture at head and neck of the humerus..... | 11.5 weeks. |
| For fracture at condyles of the humerus..... | 9.0 weeks. |
| For fracture of the shaft of both bones of the forearm.. | 10.8 weeks. |
| For fracture of the femur, all sites..... | 6.2 months. |
| For fracture of the leg, all sites..... | 4.9 months. |

NOTE.—This determination must still be held as not quite conclusive on account of the comparatively few clear reports on this point. With the assistance and coöperation of the surgeon in charge at the Dispensary of the Bethlehem Steel Company, the Chairman has been able to obtain careful data in something less than one hundred of his own cases. He finds that these prove the disability periods as stated above substantially correct. Periods of disability were not recorded accurately in the majority of the reported cases and very seldom in compound fractures. For compound fractures the average period of disability is as follows:

| | |
|---|------------|
| For fractures of the femur..... | 13 months. |
| For fractures of the leg.... | 6 months. |
| For fractures of the upper extremity..... | 4 months. |

6. The humerus should show not more than 1 cm. shortening and no appreciable angulation. Musculospiral paralysis should not result. The forearm bones should show no appreciable shortening, and pronation and supination should be unhindered. Function should always be good and no lasting pain result. Fracture of the shaft of the femur should not result

in shortening greater than 2 cm., nor in a fixed position of angulation or rotation which will affect the joints and require new habits of balancing or tilting of the pelvis; joint function should be good. No permanent disability of the affected member should result. Fracture of the shaft of the bones of the leg should result in no appreciable shortening and no angulation or rotation. Joint function should be preserved.

7. There is no method or splint universally applicable, nor has any given splint or apparatus proved its superiority. All depends upon the discrimination of the surgeon and the manner in which the apparatus is applied and maintained. It is evident that traction methods are most frequently unskillfully employed. As a rule, too little weight is used. The gauge of the proper weight required is that necessary to overcome the shortening. This should be determined by careful daily measurement. Traction methods require as a rule counter-traction.

Plaster casts and moulded splints are especially indicated and useful after a fracture has been satisfactorily reduced.

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